US Army Corps
of Engineers®
Sacramento District
Planning Division

Lower San Joaquin River Feasibility Report

San Joaquin County, California

ECONOMICS APPENDIX

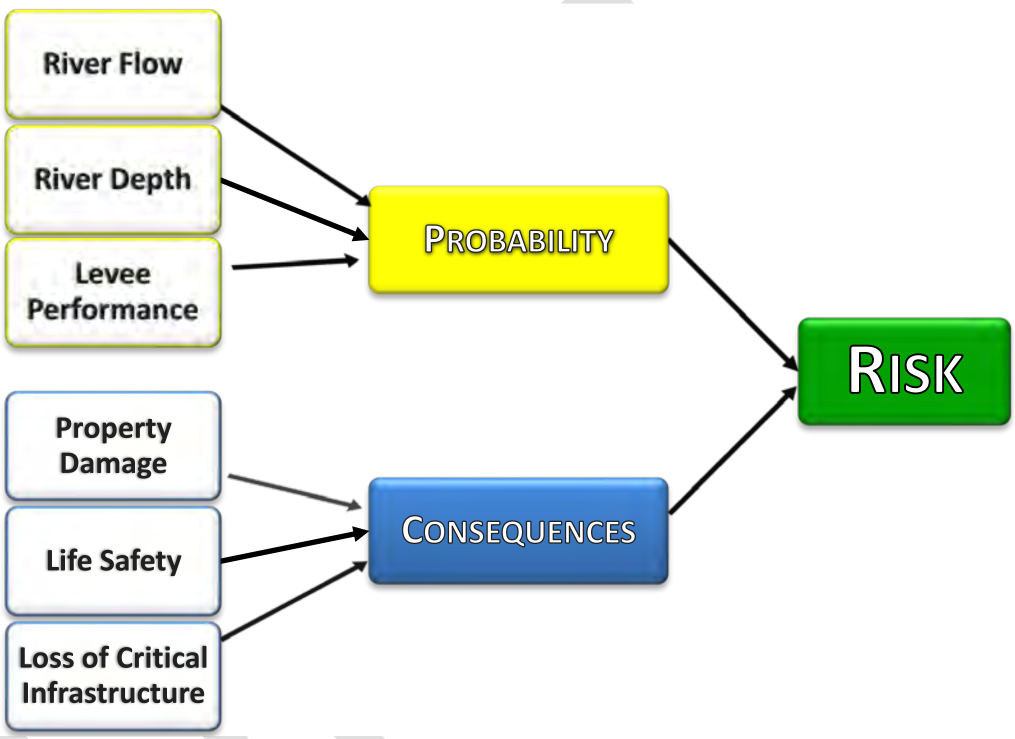
This page intentionally left blank

RISK ANALYSIS OVERVIEW

Risk is defined as the measure of the probabilities and consequences associated with uncertain future events. The objective of this economic analysis is to assess existing flood risk in the Lower San Joaquin River Basin and evaluate potential measures to reduce that risk.

The figure below provides a visual representation of the basic components driving the flood risk analysis summarized in this appendix. Each of these components will be described in detail in subsequent chapters.

COMPONENTS OF FLOOD RISK



Contents

Tables

Figures

Attachments

CHAPTER 1 — INTRODUCTION

1.1 PURPOSE & SCOPE

This Appendix documents the economic analysis conducted in support of the Lower San Joaquin River Feasibility Study (LSJRFS). The purposes of this report are:

- Describe major assumptions, data, methodologies, and tools used in the economic analysis
- Describe the flood risk associated with the without-project condition
- Describe the residual flood risk associated with each alternative.
- Summarize the net benefits and benefit-to-cost ratios of each alternative
- Identify the alternative that reasonably maximizes net benefits

1.2 BACKGROUND

The U.S. Army Corps of Engineers, together with the State of California San Joaquin Area Flood Control Agency (SJAFCA) conducted this feasibility study to select a plan that reduces flood risk. The goal of the study is to identify a cost effective, technically feasible and locally acceptable project that best reduces flood risk and complies with all Federal, State, and local laws and regulations.

The selected flood risk reduction plan may provide ancillary Ecosystem Restoration and Recreation Benefits in the study area. However, these benefits are not included in this economic analysis and will not be discussed further in this appendix.

1.3 HISTORY OF FLOODING

Major flooding has occurred in 1955, 1958, and 1997. The 1955 flood left roughly 1,500 acres of Stockton under six feet of water for as long as eight days. In 1958, approximately 8,500 acres were inundated with up to two feet of water between Bellota and the Diverting Canal with flood durations lasting up to 10 days. The 1997 flood resulted in the evacuation of the Weston Ranch area of Stockton in the northern portion of RD-17. While the 1997 event did not directly damage areas of Stockton, Lathrop, or Manteca, nearly 2,000 residences and businesses were affected in San Joaquin and Stanislaus Counties. The 1997 event caused an estimated $80 million in damage in San Joaquin County.

1.4 PROBLEMS AND OPPORTUNITIES

The purpose of this feasibility study is to recommend a reasonable and implementable plan to address problems and opportunities identified during the planning process. Please refer to Chapter Two of the Main Report for a complete account of the study's problems and opportunities. Brief descriptions of each problem and opportunity identified for the Lower San Joaquin study area are provided below.

PROBLEM — Flooding poses a significant risk to public safety, health, and property in the study area.

OPPORTUNITY — Reduce the risk of flooding from the Calaveras River, San Joaquin River, Mosher Slough, and the Sacramento-San Joaquin Delta.

OPPORTUNITY — Sustain and improve aquatic, riparian, and adjacent terrestrial habitats in conjunction with Flood Risk Management features.

OPPORTUNITY — Integrate a proposed project with other watershed-level initiatives for a holistic approach to flood risk management, ecosystem restoration, and navigation in the San Joaquin River watershed.

OPPORTUNITY — Expand current programs and to continue to educate the public about ongoing residual flood risk.

1.5 STUDY AREA

The Lower San Joaquin study area is located in San Joaquin County, California, approximately 50 miles south of Sacramento. The geographical extent of the economic analysis was established using inundation boundaries of the 0.2% annual chance exceedance (ACE) events from the flooding sources described in Section 1.6 This analysis includes roughly 80 square miles of urban and agricultural lands in the communities of Stockton, Lathrop and Manteca.

A map showing the location of the study area and its relative location within the state of California is shown in Figure 1-1 below. A map delineating urban and agricultural land use is shown in Figure 1-2.

FIGURE 1-1: STUDY AREA MAP

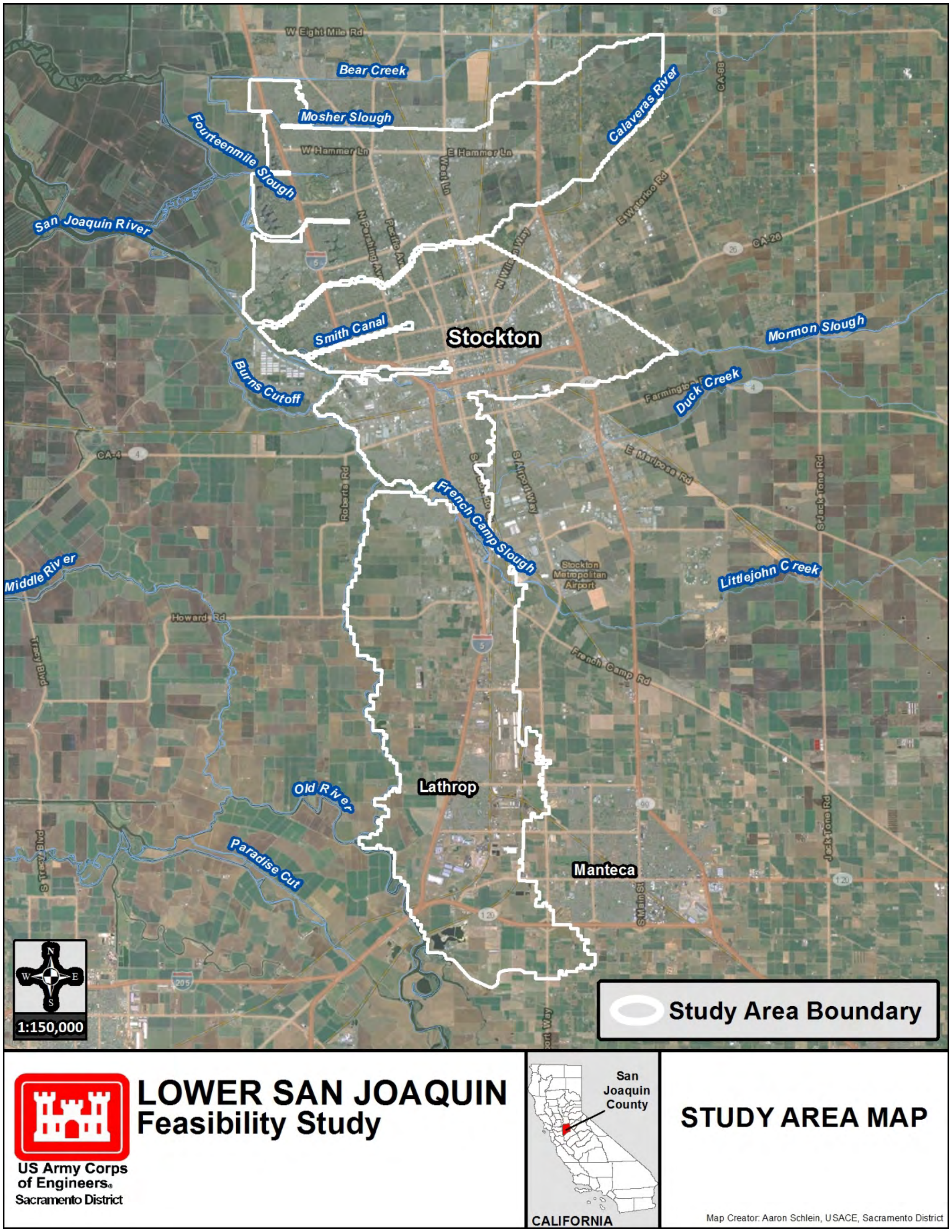
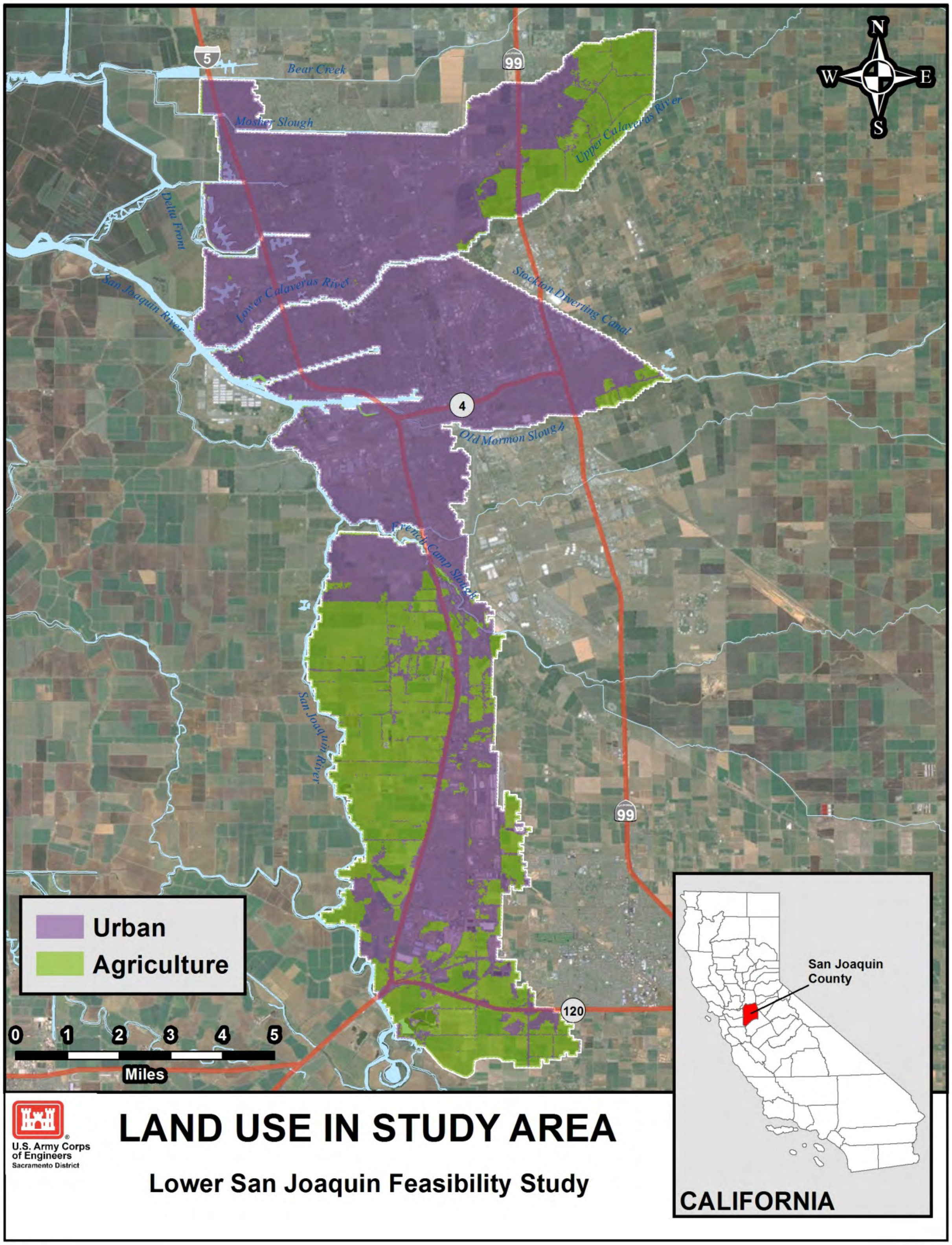


FIGURE 1-2: LAND USE MAP



1.6 SOURCES OF FLOODING

The study area is susceptible to comingled flooding from six principle sources including the Sacramento-San Joaquin Delta, San Joaquin River, Mosher Slough, Calaveras River system, French Camp Slough system, and interior sources. A complete description of each flood source within the study area can be found in Attachment 1.

1.7 RELATED FEDERAL FLOOD RISK MANAGEMENT PROJECTS

Development of water resources in the basin began in the 1850s and currently includes large multiple-purpose reservoirs, extensive levee and channel improvements, bypasses, and local diversion canals (USACE, 1993). Numerous agencies have been involved in water resources development within the study area. Some of these agencies include the USACE, Bureau of Reclamation, the State of California, county irrigation districts, local reclamation districts, and local levee districts.

The following two tables summarize existing Federal Flood Risk Management projects affecting the study area. Design flood flow projects are shown in Table 1-1, and dedicated federal flood storage projects are shown in Table 1-2. A detailed description of each project can be found in Attachment 2 of this appendix.

TABLE 1-1: PROJECT DESIGN FLOOD FLOWS

REACH	DESIGN FLOW (CFS)	DESIGN FREEBOARD (FT)	SOURCE
Mormon Slough			USACE, 1974
Bellota to Potter Creek	12,500	3 w/levee 1.5 w/o levee	USACE, 1974
Potter Creek to Diverting Canal	13,500	3 w/levee 1.5 w/o levee	USACE, 1974
Diverting Canal	13,500	3	USACE, 1974
Lower Calaveras River			
Diverting Canal to San Joaquin River	13,500	3	USACE, 1974
San Joaquin River			
Stanislaus River to Paradise Dam	52,000		USACE, 1993
Paradise Dam to Old River	37,000[1]		USACE, 1993
Old River to Stockton Deep Water Ship Channel	22,000		USACE, 1993
Duck Creek			
Duck Creek Diversion to Mariposa Road	700	Not Available	USACE, 1967
Mariposa Road to French Camp Slough	900	Not Available	USACE, 1967

[1] Design diversion capacity of Paradise Cut is 15,000 cfs

TABLE 1-2: PROJECTS WITH FEDERAL DEDICATED FLOOD STORAGE

RESERVOIR	YEAR CONSTRUCTED	GROSS POOL STORAGE (ACRE-FT)	DEDICATED FLOOD STORAGE (ACRE-FT)
Friant	1942	520,500	170,000
Big Dry Creek	1948	30,200	30,200
Farmington	1951	52,000	52,000
Comanche	1963	430,900	200,000
New Hogan	1963	317,100	165,000
Los Banos	1965	34,600	14,000
New Exchequer	1967	1,024,600	350,000
Don Pedro	1971	2,030,000	340,000
Buchanan	1975	150,000	45,000
Hidden	1975	90,000	65,000
New Melones	1979	2,400,000	450,000

1.8 SEPARABLE CONSEQUENCE AREAS

Flood risk in the study area was divided into three separable elements[1], or consequence areas, based on hydrologic and hydraulic characteristics with identifiable and distinct economic benefits. These Consequence areas are described below. A map of the Consequence area boundaries and existing levees is shown in Figure 1-3.

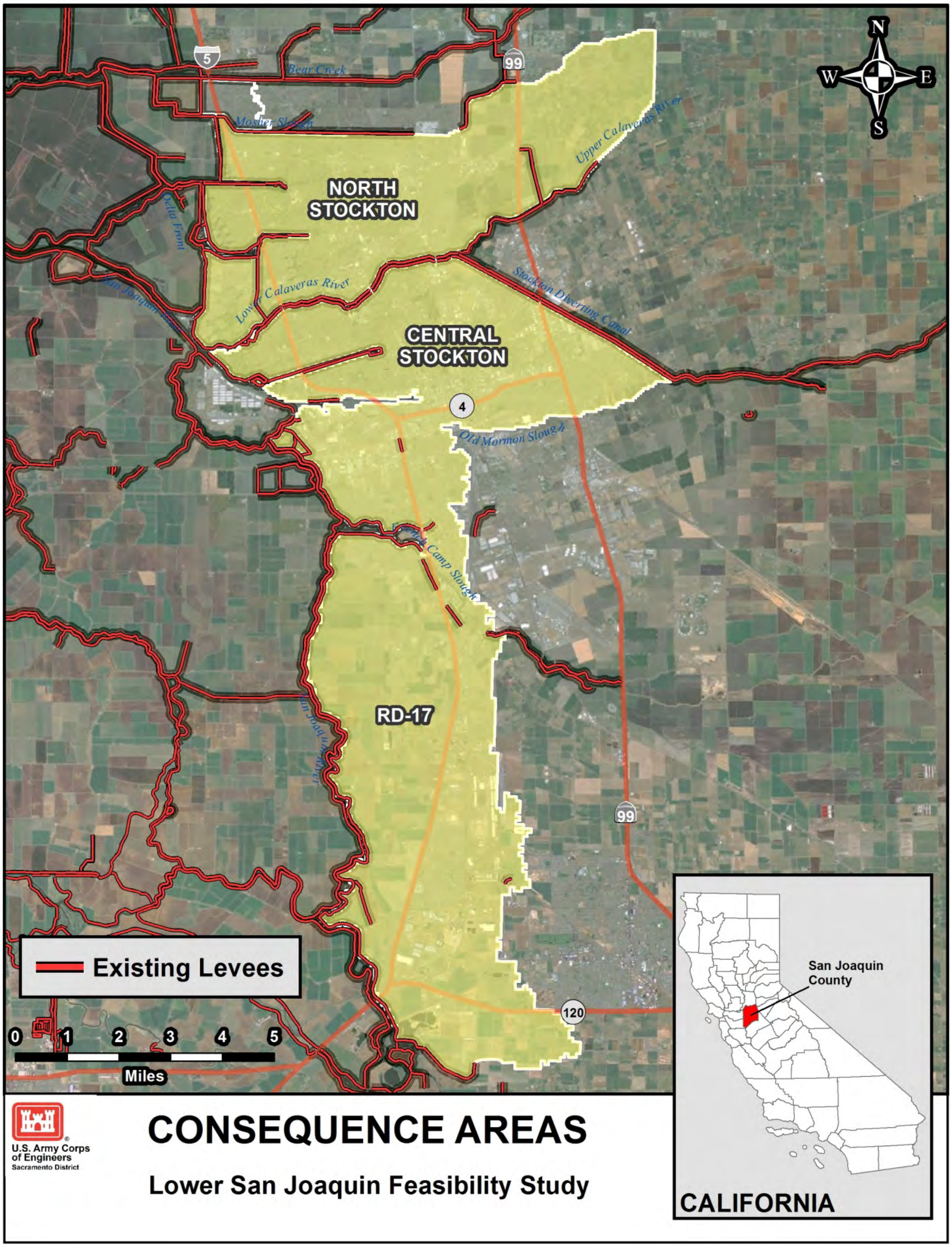
NORTH STOCKTON – The North Stockton area is defined by the right bank levees of the Calaveras River and the levees along the delta front traveling northward along Tenmile Slough, Fourteenmile Slough, crossing Fivemile Creek, and traveling north to tie into the Federal project levee across Mosher Slough at the Atlas Tract.

CENTRAL STOCKTON – The Central Stockton Area is defined by the left bank levees of the Stockton Diverting Canal, the left bank levees of the Calaveras River, the right bank levees of the San Joaquin River, and right bank levees of French Camp Slough.

RECLAMATION DISTRICT 17 (RD17) – The RD 17 area is defined by the levees along the right bank of the San Joaquin River, the left bank levees of French Camp Slough, and a dry-land levee at the upstream end of the reclamation district.

[1] "Separable element" is defined in 33 United States Code (U.S.C.) Section 2213(f) as a portion of the project that (1) is physically separable from other portions of the project; and (2)(a) achieves hydrologic effects, or (b) produces physical or economic benefits, which are separately identifiable from those produced by other portions of the project.

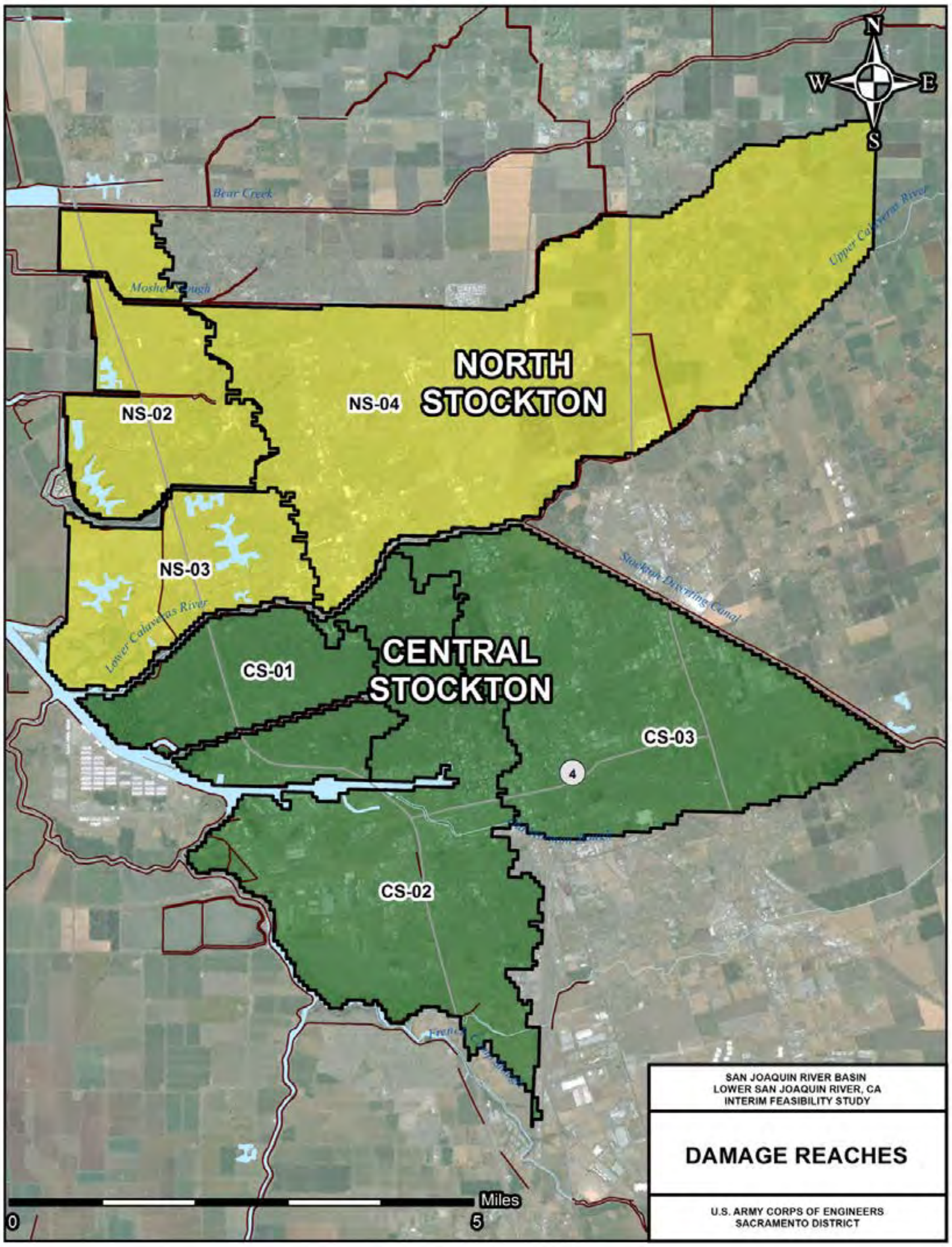
FIGURE 1-3: CONSEQUENCE AREAS



1.8.1 SUBDIVISION OF CONSEQUENCE AREAS

The North Stockton and Central Stockton consequence areas were subdivided for economic analysis purposes. Total damages for each consequence area is the sum of damages in each reach. A map of the subdivided areas is shown in Figure 1-4.

FIGURE 1-4: NORTH AND CENTRAL STOCKTON DAMAGE REACHES



1.9 POPULATION DATA

Population data for this study was obtained using a geographic information systems (GIS) layer containing 2010 census data by census block. This census data reports approximately 235,000 people residing within the study area in 2010. The population at risk by annual chance exceedance is shown in Table 1-3, and the population at risk due to levee overtopping is shown in Table 1-4. The disparity between the two tables illustrates the key role levee performance plays in safeguarding the population of the Lower San Joaquin River basin.

TABLE 1-3: POPULATION AT RISK BY ANNUAL CHANCE EXCEEDANCE

Damage Area	Population at Risk by ACE						
	0.5	**0.10**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
NS-02	13,600	18,700	19,400	20,400	21,400	22,800	23,000
NS-03	11,900	16,100	16,700	18,400	18,500	18,800	18,800
NS-04	0	0	0	26,600	32,300	35,900	38,800
CS-01	14,300	19,000	19,900	22,000	22,600	22,900	23,100
CS-02	0	0	0	36,200	42,900	47,300	47,900
CS-03	0	0	0	24,900	28,500	31,000	38,800
RD17	0	0	25,800	38,200	43,600	44,600	44,600
Total	39,800	53,800	81,800	186,700	209,800	223,300	235,000

TABLE 1-4: POPULATION AT RISK DUE TO LEVEE OVERTOPPING

Damage Area	Population at Risk by Overtopping Event						
	0.5	**0.10**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
NS-02	0	0	0	0	0	0	0
NS-03	0	0	0	0	0	0	0
NS-04	0	0	0	0	0	0	0
CS-01	0	0	0	0	0	0	23,100
CS-02	0	0	0	0	0	0	47,900
CS-03	0	0	0	0	0	0	0
RD17	0	0	0	0	0	0	44,600
Total	0	0	0	0	0	0	115,600

CHAPTER 2 — ECONOMIC ANALYSIS

2.1 CONSISTENCY WITH CURRENT REGULATIONS & POLICIES

The analysis presented in this document was performed using the most up-to-date guidance and is consistent with current regulations and policies. Various references were used to guide the economic analysis, including:

- The Planning Guidance Notebook (ER 1105-2-100, April 2000, with emphasis on Appendix D, Economic and Social Considerations, Amendment No. 1, June 2004) serves as the primary source for evaluation methods of flood risk management (FRM) studies
- EM 1110-2-1619, Engineering and Design – Risk-Based Analysis for Flood Damage Reduction Studies (August 1996)
- ER 1105-2-101, Planning Risk-Based Analysis for Flood Damage Reduction Studies (Revised January 2006)
- Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships (2000)
- Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements (2003)
- Economic Guidance Memorandum (EGM) 09-04, Generic Depth-Damage Relationships for Vehicles (2009)

2.2 PRICE LEVEL, PERIOD OF ANALYSIS, AND DISCOUNT RATE

Values listed in this document are based on an October 2013 price level. Annualized benefits and costs were computed using a 50-year period of analysis and a current federal discount rate of 3.50%. Unless otherwise noted, annualized values are presented in thousands of dollars.

2.3 HYDROLOGIC, HYDRAULIC, AND GEOTECHNICAL DATA

Flood inundation was modeled for eight ACE events at each breach location using FLO-2D software. FLO-2D stores the resulting inundation data for each model using an overlay of uniform grid cells. For this analysis, the maximum water surface elevation at each grid cell was used as an input into HEC-FDA to represent the inundation depth at each structure located within that cell.

The probability of flooding at a given breach location is driven by the following engineering inputs:

Unregulated Flow Probability — The relationship between natural (unregulated) river flow and the probability of that flow being exceeded

Unregulated to Regulated Flow Transform — The relationship between natural flow and regulated flow resulting from reservoir routing, channel routing, or channel diversion.

Discharge-Stage Relationship — The relationship between regulated flow and corresponding river depth (stage)

Geotechnical Performance — The relationship between river depth and the probability of levee overtopping and/or failure at that depth

2.4 SIMPLIFYING ASSUMPTIONS

Several assumptions were relied upon in order to make best use of scarce resources to reasonably and efficiently identify existing flood risk and evaluate potential solutions.

2.4.1 BREACH LOCATIONS

Existing levees in the study area were divided into 14 levee reaches. Breach and inundation characteristics of each levee reach were modeled using a representative index point. The use of index points is policy compliant and is considered the most reasonable method to efficiently model flood risk over a large geographical area. Index points are summarized geographically from upstream to downstream in Table 2-1 below.

TABLE 2-1: INDEX POINTS BY FLOODING SOURCE

FLOOD SOURCE	INDEX POINT
SAN JOAQUIN RIVER	LRTB
	LR4
	LR3
	LR2
	LR1
FRENCH CAMP SLOUGH	FR1
	FL1
STOCKTON DIVERTING CANAL	SL2
CALAVERAS RIVER	CR2
	CL2
SACRAMENTO-SAN JOAQUIN DELTA FRONT	D3
	D4
	D5
	D-BS

2.4.2 MULTIPLE-SOURCE FLOODING

Throughout this study, multiple sources of flooding exist within a single consequence area, and each source comes with its own unique combination of probabilities and consequences. The simplifying assumption was made that the flood source with the highest economic risk is deemed the lone driver of both without-project and residual risk in each consequence area.

It is acknowledged that overall economic risk may be slightly underestimated, as the combined probabilities and consequences of multiple levee breaches within a single consequence area are not captured by the models. This assumption is considered low risk for two reasons: (1) underestimates of without-project risk are constant across all alternatives; and (2) the probability of multiple levee failures under with-project conditions are extremely low, which causes only negligible underestimates of residual risk.

Figures 2-1 through 2-7 provide a visual representation of the index points chosen for the study. Each figure each contains two graphics. The graphic on the left shows the location of all index points analyzed for a given damage area. The graphic on the right shows the highest risk index point for the damage area and includes an overlay of the flooding associated with a levee breach for each probability-flood event. Each index point label contains the annual exceedance probability (AEP) at the representative breach location. AEP is the likelihood that flooding will occur in a given year considering the probabilities associated with the full range of engineering inputs.

FIGURE 2-1: INDEX POINTS—NORTH STOCKTON 02

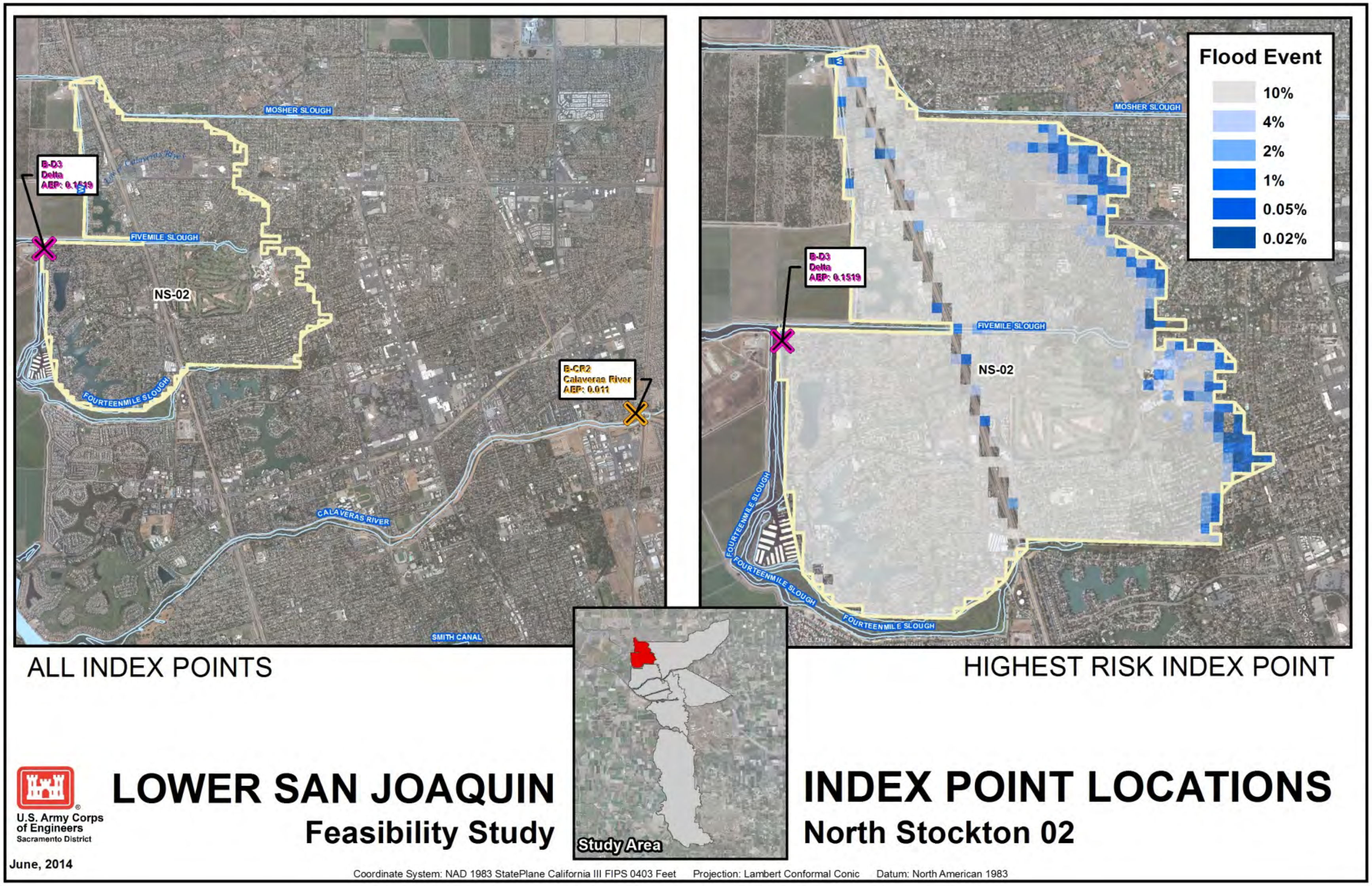


FIGURE 2-2: INDEX POINTS—NORTH STOCKTON 03

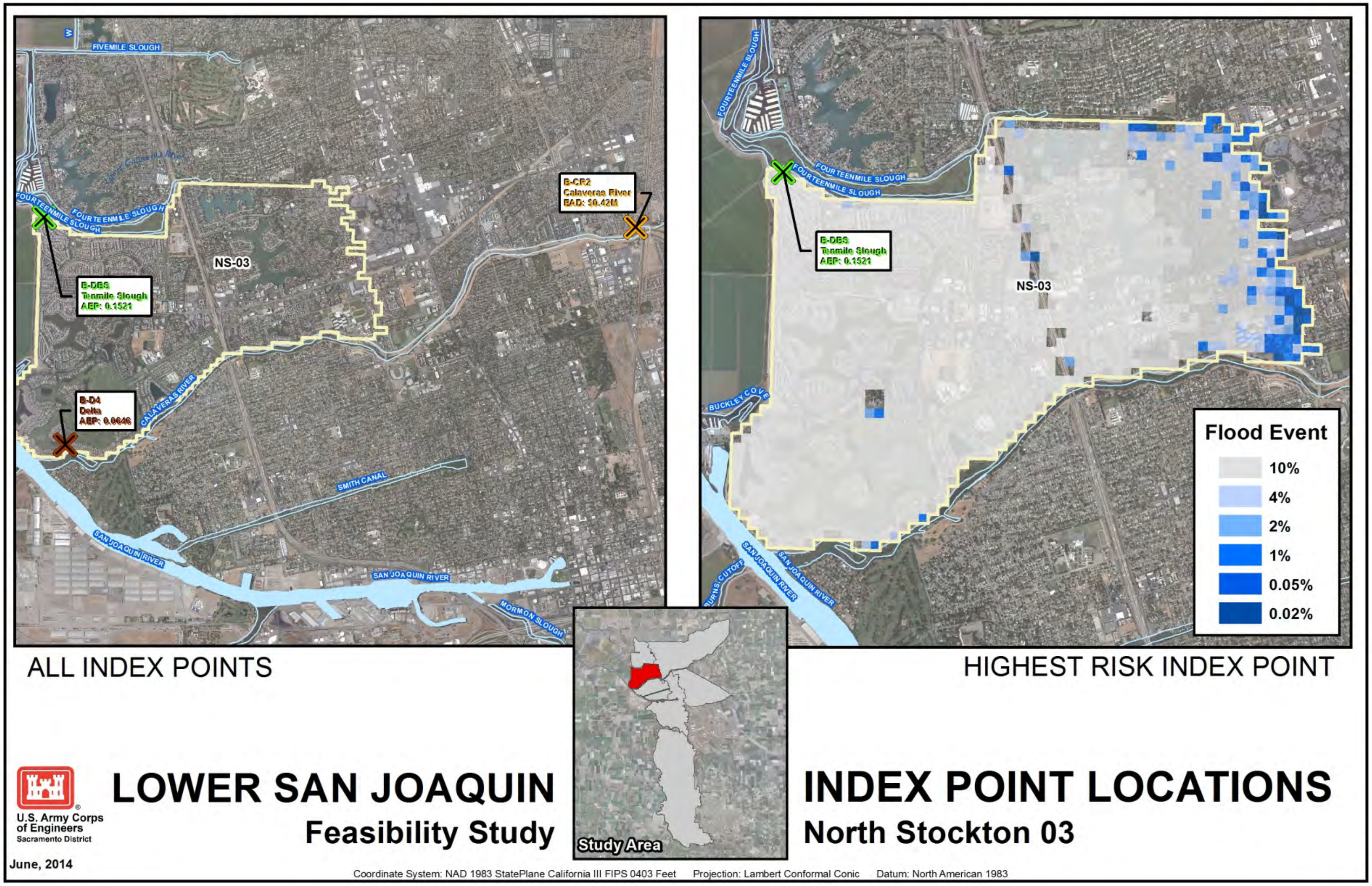


FIGURE 2-3: INDEX POINTS—NORTH STOCKTON 04

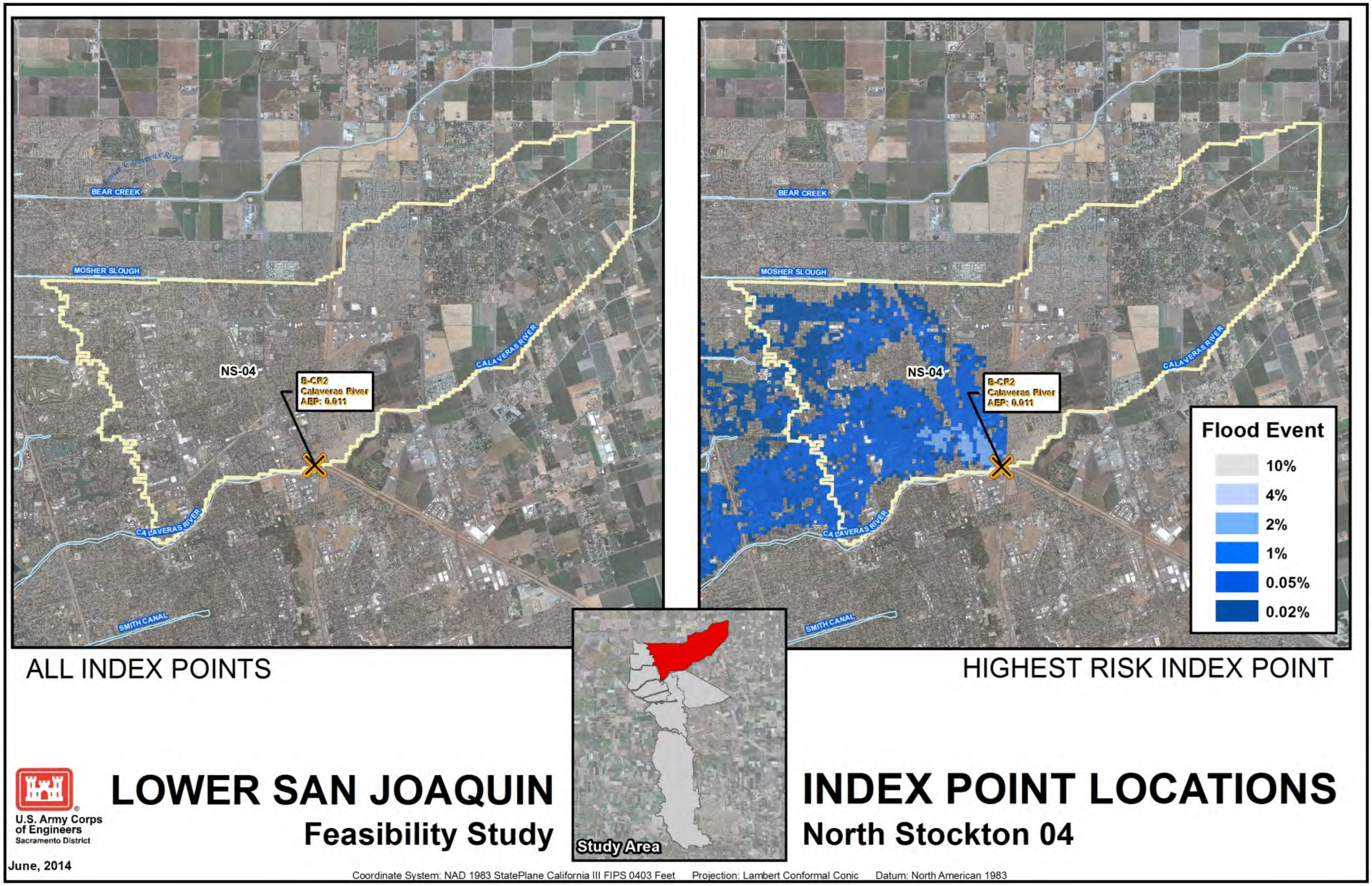


FIGURE 2-4: INDEX POINTS—CENTRAL STOCKTON 01

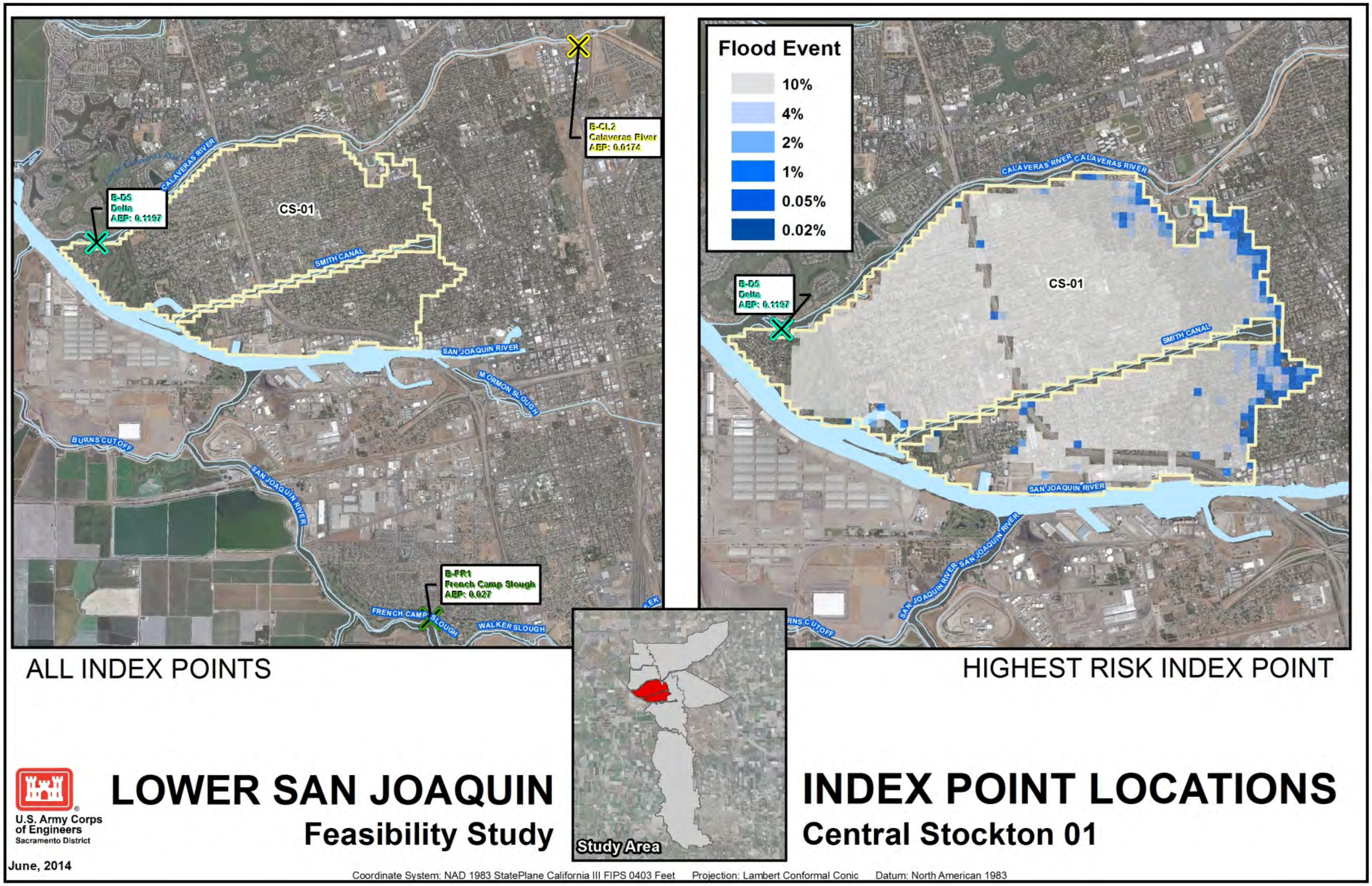


FIGURE 2-5: INDEX POINTS—CENTRAL STOCKTON 02

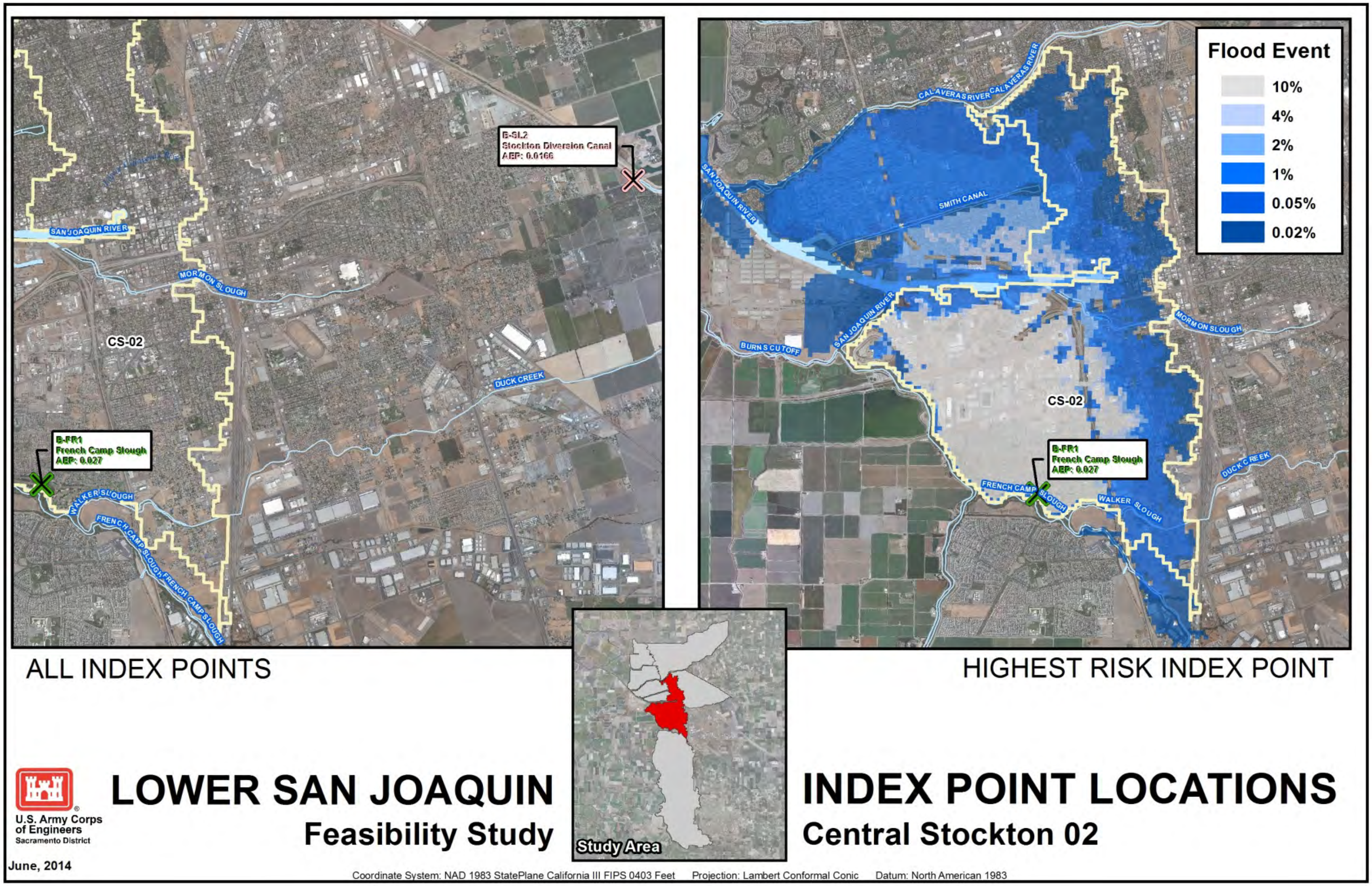


FIGURE 2-6: INDEX POINTS—CENTRAL STOCKTON 03

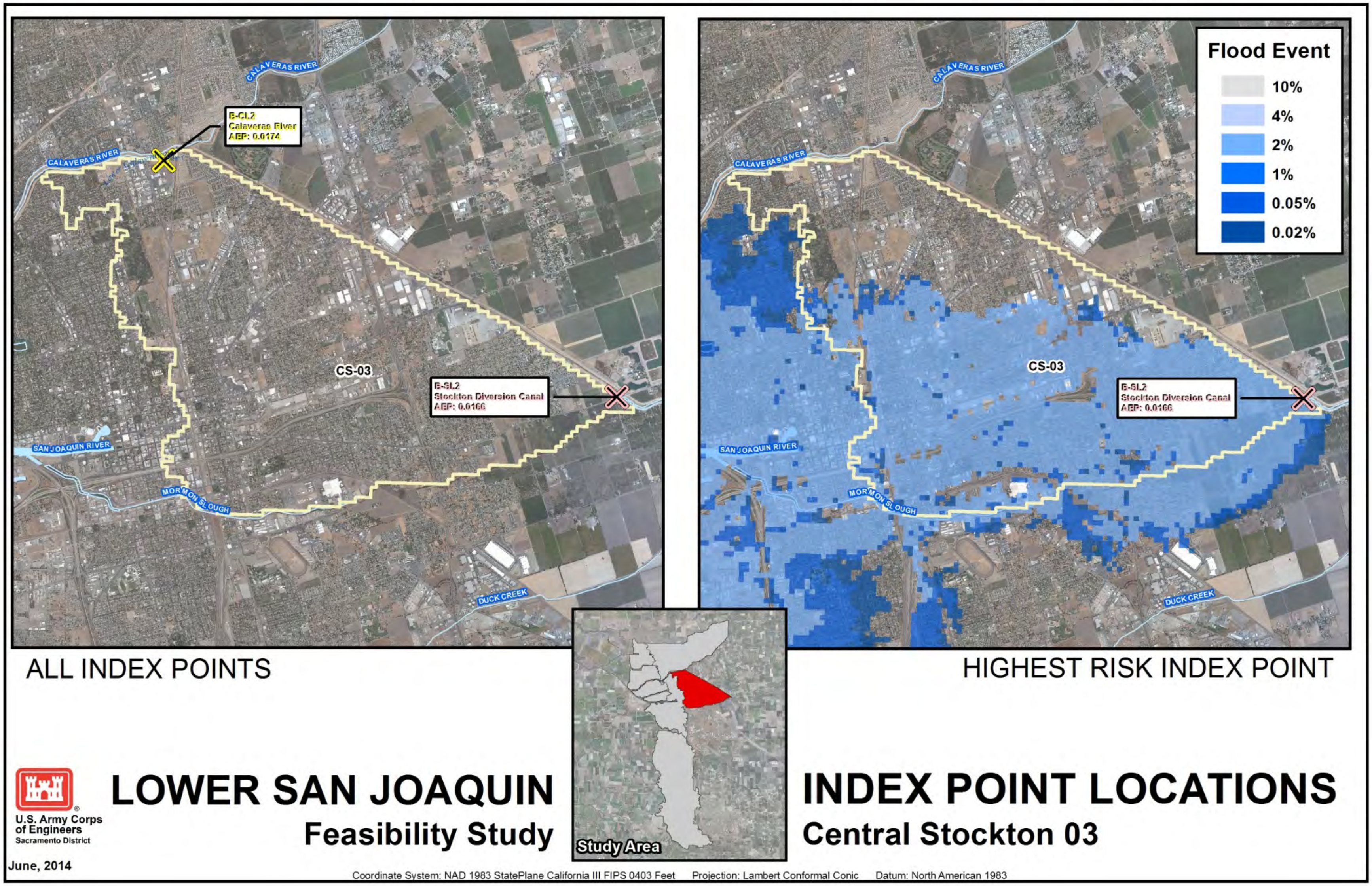
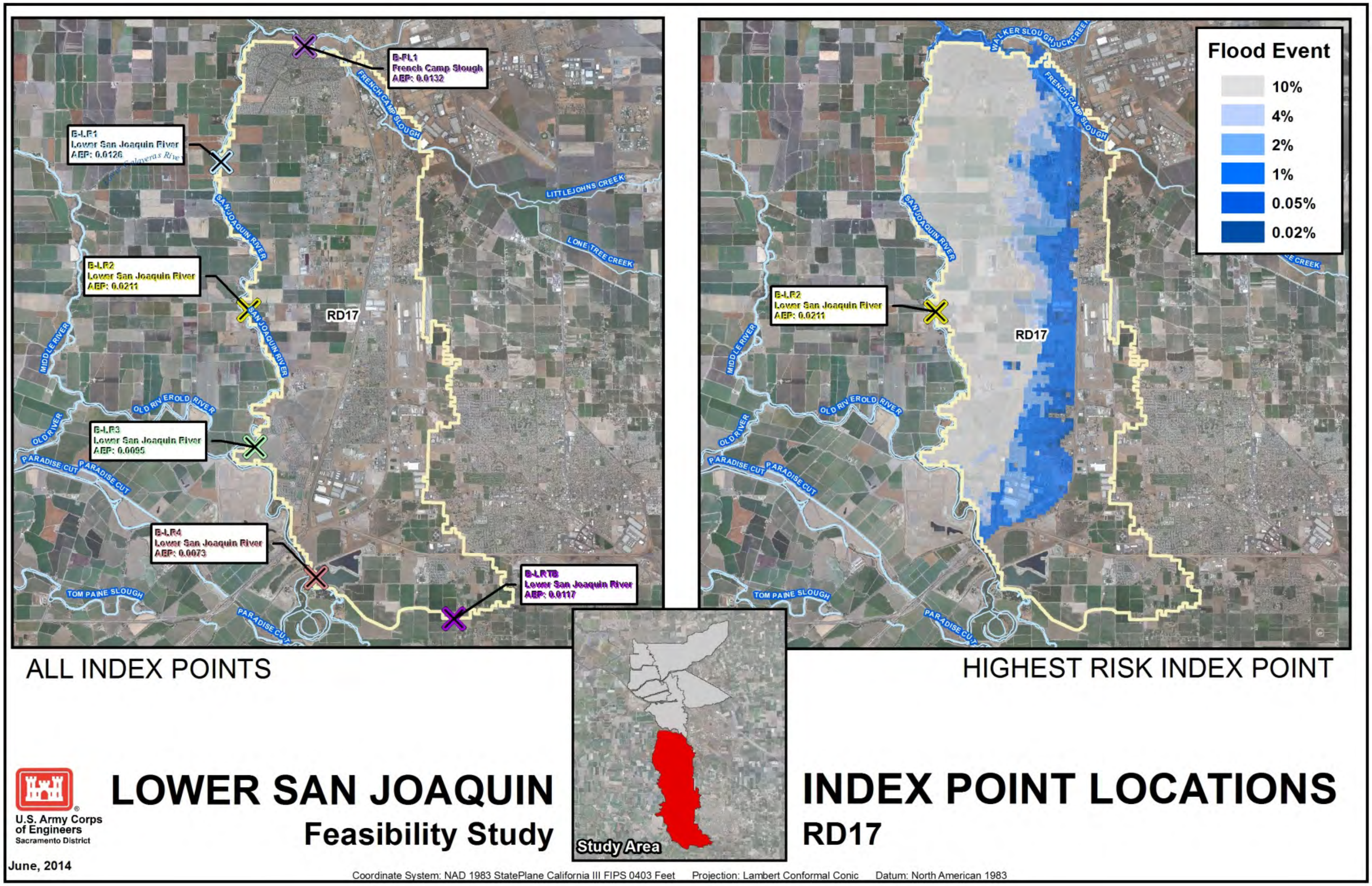


FIGURE 2-7: INDEX POINTS—RD17



2.4.3 FUTURE WITHOUT-PROJECT CONDITION—ECONOMICS

For this feasibility study analysis, the future without-project condition assumes no additional development in the study area. The basis of this assumption is that existing developable land is reasonably built out to its full potential. Additionally, development forecasts were not made for currently undeveloped portions of the study area. This is due to the uncertainty surrounding public policy decisions that may limit or prohibit such development.

2.4.4 SEA LEVEL RISE

Sea level rise is expected to impact stage-frequency at several breach locations in the study area. Hydraulic inputs for all alternatives use 2010 data to represent present-year conditions and forecasted data for the year 2070 to represent the future year. It is acknowledged that using 2010 data presents the risk of failing to capture sea level rise that may have already occurred. This risk is considered acceptable as the result is a slight underestimation of without-project damages and subsequent with-project benefits.

2.4.5 EQUIVALENT ANNUAL DAMAGES

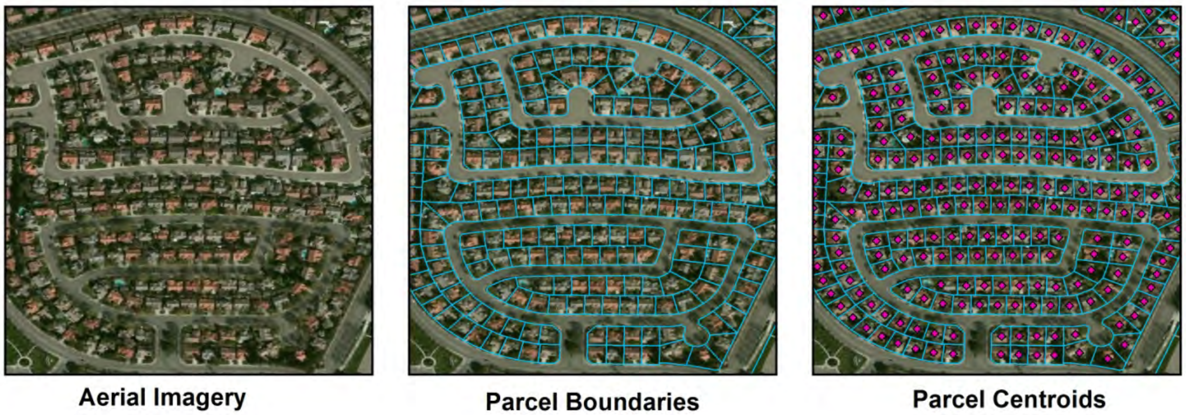
All annual damages in this appendix are reported in average annual equivalent terms. Because sea level rise is expected to lead to an upward shift in the stage-frequency relationship, higher probabilities of flooding are expected in the future, *ceteris paribus*. To capture the consequent increase in expected annual damages, a linear relationship between future damage values was assumed. Future damages are interpolated between the base and future year and discounted back to the base year.

2.4.6 STRUCTURE LOCATIONS

Structure locations were estimated using a geographic information system (GIS) parcel layer containing the boundaries of every parcel of land in the study area. The spatial accuracy of the data was confirmed using aerial imagery. The simplifying assumption was made that structures are to be located at the geometric center, or centroid, of the parcel they are located on. While it is possible to manually place each structure in its precise location using aerial imagery, doing so would provide little return on the resource investment such a task would require.

Figure 2-8 displays this structure placement process visually. It is important to note the location of the centroids in relation to the structures they represent. Any minor spatial discrepancies are believed to be low risk and are justified by the significant resource savings this method offers.

FIGURE 2-8: STRUCTURE PLACEMENT



2.5 STRUCTURE INVENTORY DATA

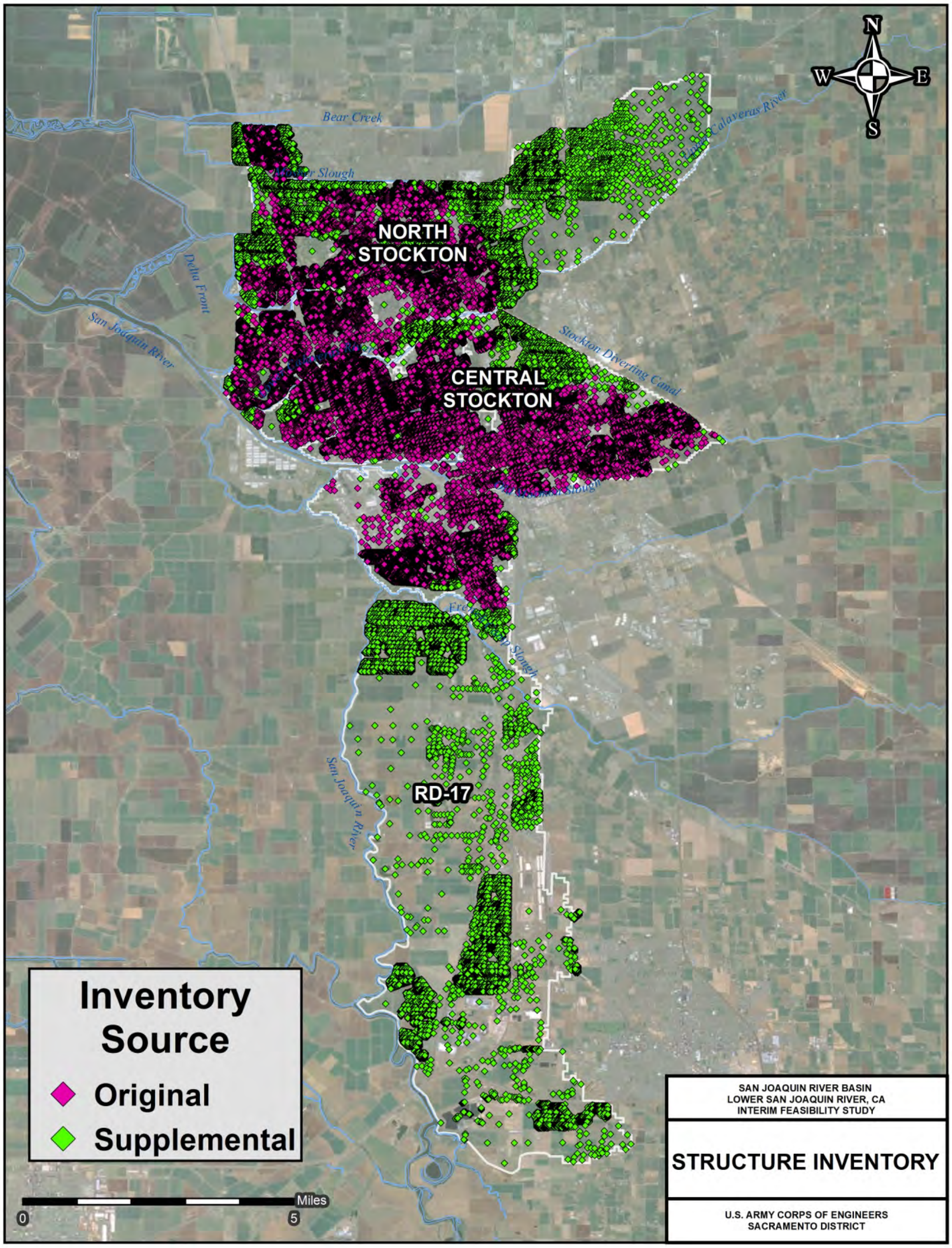
An inventory of damageable property was developed for the study in two parts. The first part was completed in 2011 by USACE Los Angeles District for use in the 2012 preliminary screening analysis. This inventory was based on San Joaquin County Assessor parcel data and included 51,856 structures and covered most of the North and Central Stockton consequence areas. The methodology used to develop the 2011 inventory is provided in Attachment 3 of this appendix.

The second part was developed in 2013 as a supplement to the existing inventory. This was critical to the study as the 2011 inventory did not include structures in RD17. Furthermore, a significant number of structures in North and Central Stockton were missing or inaccurately located. The supplementary inventory was also created using assessor parcel data.

The most notable difference between the two inventories is the valuation method. Structures in the original inventory were valuated using the depreciated replacement value method described in Attachment 3, while the supplemental structures use assessor improvement values. This was due to inadequate time and resources to conduct a proper field survey for the supplemental structures. Assessor improvement values account only for the cost of materials and labor needed to build a structure and do not include land values or trends in the real estate market.

A map of the structure inventory is shown in Figure 2-9. Note that structures from the two inventories are distinguished by color.

FIGURE 2-9: STRUCTURE INVENTORY



2.5.1 CONTENT-STRUCTURE VALUE RATIOS

The content to structure value ratio is the relationship between the value of a structure and the value of its contents. Content to structure value ratios are expressed as a percentage and are based on a structure's occupancy type. Content to structure ratios used in this study area shown in Table 2-2.

TABLE 2-2: CONTENT TO STRUCTURE RATIOS BY OCCUPANCY TYPE

DAMAGE CATEGORY	OCCUPANCY TYPE	CONTENT TO STRUCTURE RATIO
COMMERCIAL	Auto Sales	62%
	Auto Service	193%
	Fast Food Restaurant	42%
	Food Retail	42%
	Full Service Auto Dealership	69%
	Furniture Store -1 story	55%
	Furniture Store -2 story	36%
	General Retail	51%
	Grocery Store	106%
	Hospital - 1 story	92%
	Hospital - 2 story	87%
	Hotel	69%
	Medical - 1 story	148%
	Medical - 2 story	121%
	Office -1 story	34%
	Office -2 story	28%
	Restaurants - 1 story	134%
	Restaurants - 2 story	118%
	Shopping Center - 1 story	67%
	Shopping Center - 2 story	54%
INDUSTRIAL	Heavy Manufacturing - 1 story	31%
	Heavy Manufacturing - 2 story	20%
	Light Manufacturing - 1 story	188%
	Light Manufacturing - 2 story	126%
	Warehouse - 1 story	89%
	Warehouse - 2 story	85%
PUBLIC	Church - 1 story	20%
	Church - 2 story	17%
	Government Building - 1 story	35%
	Government Building - 2 story	26%
	Recreation/Assembly - 1 story	132%
	Recreation/Assembly - 2 story	58%
	School - 1 story	38%
	School - 2 story	32%
RESIDENTIAL	Mobile Home	50%
	Multi-Family Residence	100%
	Single Family Residence	100%

2.6 RISK AND UNCERTAINTY

Uncertainty is especially prevalent in the estimation of flood risk. A list of all the potential sources of uncertainty would be nearly endless. However, primary sources of uncertainty evaluated in this study include: (1) Levels of Storm Water Discharge; (2) Water Surface Elevations; (3) Levee Performance; (4) Depreciated Structure and Structure Content Values; and (5) Flood Damages to Structures and Structure Contents. The section below describes these sources of uncertainty and how each is accounted for in this analysis.

Levels of Storm Water Discharge – Uncertainty in the level of rainwater discharge associated with a storm event with a given probability of occurrence is driven by a number of inconsistent factors. Storms with equal probabilities of occurrence can differ in the amount of rainfall they produce at various locations throughout the watershed. They can also differ in their intensity, the time that elapses while rain is falling. Ground permeability, soil moisture, ambient temperature and other physical factors at the time of the storm also play an important role in determining when and where rainwater enters the river's channel. All of these natural factors lead to variability in the level of discharge found at a particular location along the river, following any given storm event.

Water Surface Elevation – For a given level of discharge, there is uncertainty in the expected water surface elevations for specific locations within the channel. The shape of the riverbed, water temperature, location and amount of debris as well as other obstructions in the channel all add uncertainty to the estimated water surface elevations associated with storms of otherwise equal levels of discharge. To address this uncertainty, engineering data inputs were used to estimate standard deviations for various river stages. These estimated standard deviations are based on level of discharge and location in the floodplain.

Levee Performance – For a given water surface elevation, there is uncertainty in the ability of the levees and banks to contain flood flows without structural failure. For this report, existing levees and those constructed as part of the SARM project were not assumed to fail prior to being overtopped. Levee and bank elevations were entered into the computer program described in the computer aided analysis section below, to ensure flooding was explicitly limited to those events in which the water surface elevation exceeds the top of bank/levee height.

Structure Elevations – The susceptibility of a structure to damage depends on a number of uncertain variables. One key variable, the structure elevation, can be decomposed into two error prone estimates: topographic and first floor elevations. The level of uncertainty in structures' topographic elevations is a function of the accuracy of data used to derive ground elevations. For example, elevation estimates derived from examining a five-foot contour map are likely to contain more error, and therefore have higher levels of uncertainty, than estimates derived using a two-foot aerial survey contour map. The second source of uncertainty in elevation data is the result of error in first floor or foundation height estimates. Foundation height data is important since structures built on land mounds or those with large crawl spaces may sustain little or no damage during floods that inundate surrounding areas and nearby properties. First floor height data error varies according to the precision of the method used to measure foundation heights. In practice, these methods range from best-guess estimates to windshield and professional surveys.

Depreciated Structure and Content Replacement Values – The magnitude of damages to a particular structure following a given flood event is a function of its current, depreciated replacement value and the value of its contents. The current or depreciated value of a structure is uncertain for several reasons. First, per square foot structure values are calculated by estimating the construction type, quality and condition of structures during field surveys. These estimates are subject to human error associated with incorrectly classifying a structure within each category. The type, construction quality and condition classifications themselves may further induce error if they do not adequately account for the proper range of possible per square foot values. Further detail on structure valuation for this study can be found in Attachment 3.

FLOOD DAMAGES TO STRUCTURES AND STRUCTURE CONTENTS – Finally, there is considerable uncertainty in evaluating structure and content damages that would occur given a particular level of flooding. The value of damage to non-residential structures' contents was estimated using a method developed during an expert-opinion elicitation process, conducted by the Sacramento District USACE and published in Technical Report: Content Valuation and Depth Damage Curves for Nonresidential Structures, May 2007. Using this methodology, the structure's use (retail, agricultural, residential, etc…) and depreciation is correlated with the value of its contents. Damages to these contents during a hypothetical flooding event are then estimated using depth-damage functions published in the report. Residential structures' content values and damages were evaluated using depth-damage functions and associated standard error estimates developed by the IWR. Hypothetical damages to residential and non-residential structures during various flood events were also evaluated using IWR depth-damage curves. These depth-damage functions and standard error estimates are based upon the damages that actually occurred during previous flood events in the United States.

2.7 HEC-FDA SOFTWARE

The primary analytical tool used to perform the economic analysis was the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software, version 1.2.5a. This program uses engineering and economic data to model flood risk with uncertainty and evaluate potential solutions in the study area.

By relating the economic inventory data to floodplain data, HEC-FDA computes economic stage-damage curves. Through integration of stage-damage curves and the engineering variables described in Section 2.3, HEC-FDA computes project performance statistics and expected annual damages.

The figure below demonstrates how risk and uncertainty parameters are utilized by HEC-FDA to develop point estimates used in Monte Carlo simulations. In step one, a frequency-discharge function with risk and uncertainty parameters is entered into HEC-FDA. This frequency-discharge function relates storm events with a given probability of occurrence in any given year to storm discharge flows. The solid black line, next to number one in the figure below, represents the expected values of this function;[1] the dotted black lines represent risk and uncertainty parameters entered into HEC-FDA.[2] These risk and uncertainty parameters at various points along the graphed line form the foundation of probability distribution functions, like the one shown to the right of point one.[3] Within a single iteration of a Monte Carlo simulation, the HEC-FDA program first selects a probabilistic event. Given an event with the

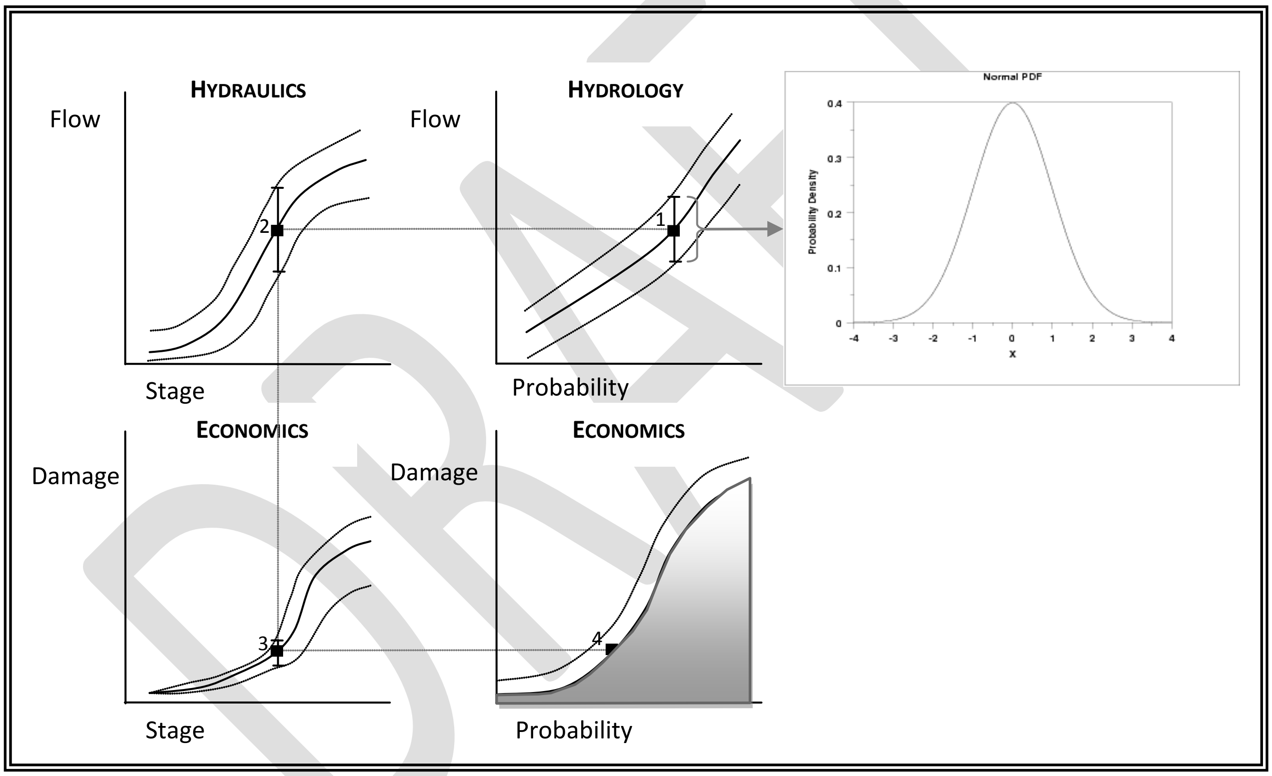
[1] In other words, the "most likely" level of storm discharge resulting from a storm event with a particular probability of occurrence (i.e. 1 percent ACE)

[2] For instance, a 95 percent confidence interval, indicating the range of storm discharge flows that 95 percent of 1 percent ACE would generate.

[3] In this case, the probability distribution function assigns probabilistic values to each potential storm discharge flow that could result from a particular storm event (i.e. the 1 percent ACE).

probability of occurrence represented by point one, a storm flow is drawn from this event's storm flow probability distribution function. The possible storm flow values for this probability event are symbolized with the candlesticks above and below point one in the figure below. Next, the storm discharge is linked to a river stage via a stage-discharge function, entered into HEC-FDA with risk and uncertainty parameters. Again, uncertainty parameters characterize probability distribution functions along the stage-discharge function, graphed about point two. In step three, damages are associated with the river stage *selected* in step two, via a third probability function.[4] This damage estimate, generated within a single Monte Carlo iteration is represented by point four along the cumulative distribution function below, which relates damages to storm events with a particular probability of occurrence in any given year. The damage results, produced in successive iterations of the Monte Carlo process, complete the cumulative distribution function and provide expected annual damage values with uncertainty.

FIGURE 2-10: DAMAGE ANALYSIS IN HEC-FDA WITH MONTE CARLO SIMULATIONS



2.8 PROJECT BENEFIT CALCULATION

Benefits for each alternative are based on the reduction in economic damages as compared to the without-project condition.

[4] Levels of storm discharge, river stage and damages are *selected* in the sense that they are drawn at random from a probability distribution function.

The benefits of all alternatives are based on a 50-year period of analysis beginning the year that a federal project would likely be completed. It is possible that differing construction schedules will result in varying base years among the alternatives.

CHAPTER 3 — EXISTING CONDITIONS ANALYSIS

3.1 CONSEQUENCE VARIABLES

Consequences in this study are defined as property damage, life-loss, and loss of critical infrastructure due to levee breach for a given annual chance exceedance (ACE) event. The variables that factor into consequence estimation are described in the following sections.

3.1.1 STRUCTURES AND CONTENTS

Structures were categorized by land use and classified as residential, commercial, industrial, or public. Structure counts by land use and consequence area are shown in Table 3-1 below. The total value of structures, contents, and automobiles within the Lower San Joaquin study area is estimated at $25 billion. Structure and content values by consequence area and occupancy type are summarized in Table 3-2.

TABLE 3-1: STRUCTURES IN THE 0.2% ACE FLOODPLAIN

CONSEQUENCE AREA	NUMBER OF STRUCTURES				
	COMMERCIAL	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
North Stockton	1,273	68	113	32,322	33,776
Central Stockton	1,593	605	360	30,843	33,401
RD 17	253	238	50	12,147	12,688
Total	3,119	911	523	75,312	79,865

TABLE 3-2: VALUE OF DAMAGEABLE PROPERTY

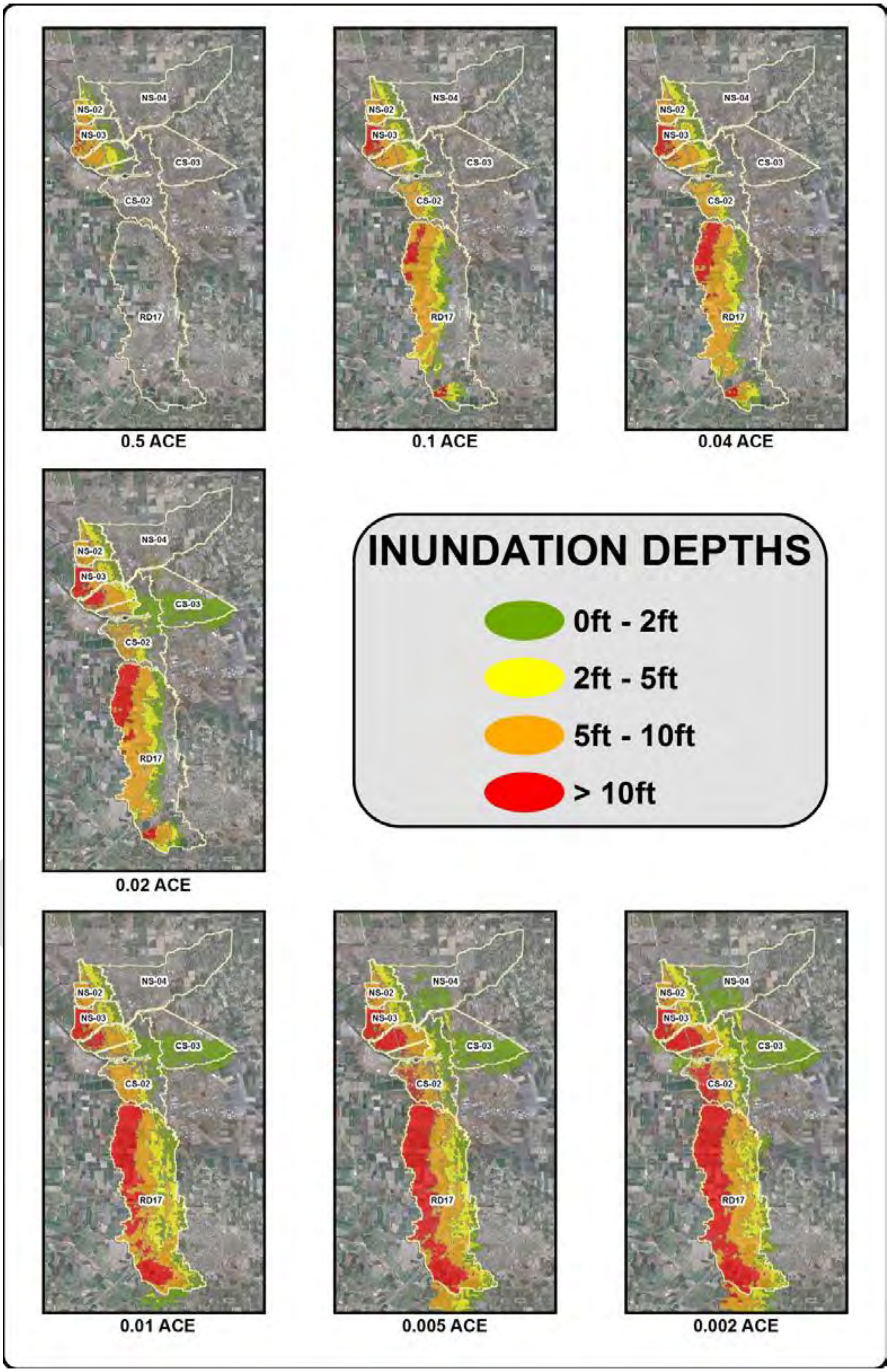
CONSEQUENCE AREA	STRUCTURE AND CONTENT VALUES					
	AUTOS	COMMERCIAL	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
North Stockton	384,000	2,158,000	107,000	391,000	8,220,000	11,260,000
Central Stockton	301,000	1,751,000	1,784,000	729,000	3,976,000	8,541,000
RD 17	110,000	290,000	1,803,000	104,000	2,944,000	5,251,000
Total	795,000	4,199,000	3,694,000	1,224,000	15,140,000	25,052,000

3.1.2 DEPTH OF FLOODING

As discussed in section 2.3, hydraulic models estimate the flooding depths that would occur following a levee breach for a given ACE event. The results of these models are used to estimate single-event consequences of a levee failure and do not account for the probability of the breach actually occurring. Flood depths are a critical component of consequence estimation, as there is a positive correlation between depth of flooding and property damage, life-loss, and loss of critical infrastructure. Please refer to Chapter 3 of the hydraulic design appendix for an in-depth description of potential flooding conditions.

Figure 3-1 contains inundation maps with corresponding depths for each ACE event in the study area.

FIGURE 3-1: EXISTING CONDITION INUNDATION MAPS BY ACE EVENT



3.1.3 DEPTH-PERCENT DAMAGE FUNCTIONS

Depth-percent damage functions represent the relationship between inundation depth at a structure and the percentage of damage caused by that depth. Economic damage is calculated as a percentage of damage specified by the depth-percent damage function multiplied by the total value of structure and contents. Depth-percent damage functions for structures and contents by occupancy type can be found in Attachment 4.

3.1.4 SINGLE EVENT DAMAGES

Single-event damages are the total damages resulting from a levee breach during a given ACE event. Single-event damages lie solely on the consequences side of the risk equation, as none of the variables driving flood probability are considered. Single-event damages were calculated for the 0.5, 0.1, 0.04, 0.02, 0.01, 0.005 and 0.002 ACE flood events using the HEC-FDA model.

TABLE 3-3: SINGLE-EVENT DAMAGES—NORTH STOCKTON 02—INDEX POINT CR2

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	0	0	0	0	0	13	2,558
Residential	0	0	0	0	0	0	3,447	60,551
Public	0	0	0	0	0	0	0	125
Industrial	0	0	0	0	0	0	0	558
Commercial	0	0	0	0	0	0	35	2,860
TOTAL	0	0	0	0	0	0	3,495	66,652

TABLE 3-4: SINGLE-EVENT DAMAGES—NORTH STOCKTON 02—INDEX POINT D3

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	44,576	63,824	66,901	68,382	69,816	82,547	84,287
Residential	0	311,222	483,803	512,504	527,899	542,980	665,389	695,458
Public	0	7,168	19,081	20,375	20,919	22,761	35,910	32,064
Industrial	0	3,911	7,133	7,558	7,761	7,958	9,979	10,773
Commercial	0	23,715	59,346	68,273	73,124	77,363	101,605	104,974
TOTAL	0	390,593	633,188	675,610	698,086	720,878	895,430	927,555

TABLE 3-5: SINGLE-EVENT DAMAGES—NORTH STOCKTON 03—INDEX POINT CR2

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	0	0	0	5,082	16,621
Residential	0	0	0	0	0	2,788	146,403	296,136
Public	0	0	0	0	0	0	3,474	9,323
Industrial	0	0	0	0	0	0	0	1,189
Commercial	0	0	0	0	0	0	44,056	72,551
TOTAL	0	0	0	0	0	2,788	199,015	395,820

TABLE 3-6: SINGLE-EVENT DAMAGES—NORTH STOCKTON 03—INDEX POINT D4

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	30,412	43,370	45,716	46,922	48,126	49,399	50,678
Residential	2,788	489,094	643,334	669,529	684,099	696,674	709,927	722,847
Public	0	12,967	18,191	18,423	18,583	18,721	20,841	24,322
Industrial	0	3,057	3,102	3,109	3,112	3,114	3,117	3,120
Commercial	0	128,753	188,878	195,702	199,042	202,937	206,799	210,673
TOTAL	2,788	664,283	896,874	932,479	951,758	969,572	990,083	1,011,640

TABLE 3-7: SINGLE-EVENT DAMAGES—NORTH STOCKTON 03—INDEX POINT D-BS

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	0	0	0	59,269	61,810
Residential	0	0	0	0	0	2,788	808,034	839,206
Public	0	0	0	0	0	0	31,875	33,241
Industrial	0	0	0	0	0	0	3,139	3,146
Commercial	0	0	0	0	0	0	231,713	238,356
TOTAL	0	0	0	0	0	2,788	1,134,030	1,175,759

TABLE 3-8: SINGLE-EVENT DAMAGES—NORTH STOCKTON 04—INDEX POINT CR2

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	0	0	0	0	298	3,728	6,316
Residential	0	0	0	0	0	11,643	121,614	191,283
Public	0	0	0	0	0	221	2,090	5,021
Industrial	0	0	0	0	0	1,076	4,755	7,968
Commercial	0	0	0	0	0	4,866	65,561	96,570
TOTAL	0	0	0	0	0	18,104	197,748	307,159

TABLE 3-9: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 01—INDEX POINT CL2

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	0	0	0	0	0	3,333	15,981
Residential	0	0	0	0	0	0	101,268	224,512
Public	0	0	0	0	0	0	1,616	10,804
Industrial	0	0	0	0	0	0	0	23
Commercial	0	0	0	0	0	0	3,856	20,078
TOTAL	0	0	0	0	0	0	110,074	271,397

TABLE 3-10: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 01—INDEX POINT D5

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	24,688	40,985	43,998	45,530	47,025	59,932	63,126
Residential	0	253,349	415,541	446,103	461,402	477,533	602,215	642,667
Public	0	14,277	18,241	22,830	24,850	26,854	43,068	46,872
Industrial	0	22,723	49,764	54,160	55,681	57,139	69,870	74,811
Commercial	0	27,993	39,997	42,054	42,879	43,687	52,537	54,732
TOTAL	0	343,030	564,528	609,145	630,342	652,238	827,623	882,208

TABLE 3-11: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 01—INDEX POINT FR1

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	69	2,972	19,634	63,965	72,288
Residential	0	0	0	8,378	52,530	250,798	640,500	769,660
Public	0	0	0	22	371	6,933	44,679	59,821
Industrial	0	0	0	1,138	23,967	67,982	78,006	83,936
Commercial	0	0	0	719	3,431	17,002	56,084	61,323
TOTAL	0	0	0	10,325	83,271	362,348	883,235	1,047,027

TABLE 3-12: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 02—INDEX POINT FR1

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	16,350	18,824	20,189	25,535	39,743	61,422
Residential	0	0	156,349	182,111	202,332	262,389	425,446	635,801
Public	0	0	20,256	23,388	25,423	32,678	54,534	158,083
Industrial	0	0	302,314	345,973	375,807	429,568	536,035	590,564
Commercial	0	0	33,912	42,956	52,596	100,516	241,158	400,367
TOTAL	0	0	529,181	613,253	676,347	850,685	1,296,917	1,846,237

TABLE 3-13: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 02—INDEX POINT SL2

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	0	0	16,638	43,321	58,022
Residential	0	0	0	0	0	235,595	476,609	607,263
Public	0	0	0	0	0	39,716	133,758	163,413
Industrial	0	0	0	0	0	168,774	288,437	324,328
Commercial	0	0	0	0	0	334,027	470,743	554,720
TOTAL	0	0	0	0	0	794,749	1,412,868	1,707,746

TABLE 3-14: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 03—INDEX POINT CL2

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	0	0	90	960	1,126
Residential	0	0	0	0	0	2,700	11,637	15,769
Public	0	0	0	0	0	293	1,529	2,882
Industrial	0	0	0	0	0	3,483	23,786	28,285
Commercial	0	0	0	0	0	1,499	13,863	15,988
TOTAL	0	0	0	0	0	8,065	51,776	64,049

TABLE 3-15: SINGLE-EVENT DAMAGES—CENTRAL STOCKTON 03—INDEX POINT SL2

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	0	0	0	7,382	9,916	12,027
Residential	0	0	0	0	0	172,022	192,442	206,606
Public	0	0	0	0	0	13,746	16,246	17,932
Industrial	0	0	0	0	0	76,209	93,210	107,673
Commercial	0	0	0	0	0	63,282	81,267	90,955
TOTAL	0	0	0	0	0	332,640	393,082	435,194

TABLE 3-16: SINGLE-EVENT DAMAGES—RD17—INDEX POINT LR1

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	33,578	42,612	47,087	57,965	65,735	70,001
Residential	0	0	366,262	473,042	528,203	672,276	816,939	883,516
Public	0	0	17,040	22,230	24,254	28,657	37,852	44,495
Industrial	0	0	24,071	47,576	56,008	198,458	483,184	545,915
Commercial	0	0	7,866	28,282	30,388	41,555	70,837	83,526
TOTAL	0	0	448,817	613,742	685,939	998,911	1,474,547	1,627,453

TABLE 3-17: SINGLE-EVENT DAMAGES—RD17—INDEX POINT LR2

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	42,425	53,429	58,331	66,996	76,685	80,754
Residential	0	0	473,019	604,291	676,789	834,854	965,234	1,015,574
Public	0	0	21,960	26,399	28,858	39,117	52,583	55,118
Industrial	0	0	46,154	65,921	254,358	503,061	607,093	644,994
Commercial	0	0	28,255	33,462	45,273	74,068	96,669	104,332
TOTAL	0	0	611,813	783,502	1,063,609	1,518,096	1,798,265	1,900,773

TABLE 3-18: SINGLE-EVENT DAMAGES—RD17—INDEX POINT LR3

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	46,209	65,970	71,114	82,174	89,536	92,183
Residential	0	0	506,696	813,104	884,985	1,036,997	1,133,851	1,176,047
Public	0	0	19,428	38,045	43,887	55,598	59,215	60,408
Industrial	0	0	79,179	482,405	537,398	655,376	733,803	771,011
Commercial	0	0	16,089	70,679	85,058	105,819	116,220	119,125
TOTAL	0	0	667,601	1,470,203	1,622,442	1,935,964	2,132,625	2,218,773

TABLE 3-19: SINGLE-EVENT DAMAGES—RD17—INDEX POINT LR4

DAMAGE CATEGORY	ACE EVENT							
	0.5	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
Autos	0	0	504	1,284	2,336	51,273	72,292	71,936
Residential	0	0	13,118	26,081	45,458	586,136	872,140	879,043
Public	0	0	0	277	1,098	43,793	50,832	49,303
Industrial	0	0	13	118	162	882,024	573,260	597,639
Commercial	0	0	315	932	1,300	85,251	74,816	76,824
TOTAL	0	0	13,949	28,692	50,355	1,648,478	1,643,341	1,674,744

TABLE 3-20: SINGLE-EVENT DAMAGES—RD17—INDEX POINT LRTB

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	0	504	1,284	2,336	51,273	72,292	71,936
Residential	0	0	13,118	26,081	45,458	586,136	872,140	879,043
Public	0	0	0	277	1,098	43,793	50,832	49,303
Industrial	0	0	13	118	162	882,024	573,260	597,639
Commercial	0	0	315	932	1,300	85,251	74,816	76,824
TOTAL	0	0	13,949	28,692	50,355	1,648,478	1,643,341	1,674,744

TABLE 3-21: SINGLE-EVENT DAMAGES—RD17—INDEX POINT FL1

DAMAGE CATEGORY	ACE EVENT							
	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Autos	0	0	33,578	42,612	47,087	57,965	65,735	70,001
Residential	0	0	366,262	473,042	528,203	672,276	816,939	883,516
Public	0	0	17,040	22,230	24,254	28,657	37,852	44,495
Industrial	0	0	24,071	47,576	56,008	198,458	483,184	545,915
Commercial	0	0	7,866	28,282	30,388	41,555	70,837	83,526
TOTAL	0	0	448,817	613,742	685,939	998,911	1,474,547	1,627,453

3.2 PROBABILITY VARIABLES

The overall likelihood that flooding will occur in a given year is dependent on the probabilities associated with the engineering inputs described in section 2.3. Tables 3-22 through 3-28 summarize the engineering inputs for the highest risk index point for each damage area. Engineering inputs for all index points are provided in Attachment 5.

TABLE 3-22: ENGINEERING INPUTS—NORTH STOCKTON 02—2010 WITHOUT PROJECT

INDEX POINT D3						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0			2.00	0.0000
0.95	0	0	0	3.18	6.00	0.0928
0.50	21,899	2,424	2,424	7.70	8.50	0.2098
0.10	79,122	9,864	9,864	9.30	11.00	0.3419
0.04	124,892	11,158	11,158	9.70	13.20*	0.4593
0.02	167,074	12,298	12,298	9.90	13.21	1.0000
0.01	216,499	15,920	15,920	10.10		
0.005	273,861	28,712	28,712	12.12		
0.002	363,117	33,013	33,013	13.01		

* Top of levee stage

TABLE 3-23: ENGINEERING INPUTS—NORTH STOCKTON 03—2010 WITHOUT PROJECT

INDEX POINT D-BS						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0	0	3.18	-3.50	0.0000
0.50	21,899	2,424	2,424	7.70	6.00	0.0743
0.10	79,122	9,864	9,864	9.29	10.00	0.2006
0.04	124,892	11,158	11,158	9.70	14.00	0.5153
0.02	167,074	12,298	12,298	9.90	18.00*	0.8532
0.01	216,499	15,920	15,920	10.10	18.01	1.0000
0.005	273,861	28,712	28,712	12.12		
0.002	363,117	33,013	33,013	13.01		

* Top of levee stage

TABLE 3-24: ENGINEERING INPUTS—NORTH STOCKTON 04—2010 WITHOUT PROJECT

INDEX POINT CR2						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0	0	6.60	23.80	0.0000
0.50	6,901	3,848	3,848	19.13	25.30	0.0892
0.20	15,360	9,496	9,496	23.35	26.90	0.1783
0.10	21,654	9,861	9,861	23.58	28.20	0.3036
0.04	29,659	12,282	12,282	24.81	29.66[*]	0.4846
0.02	35,396	12,846	12,846	25.11	29.76	1.0000
0.01	40,815	15,359	15,359	26.29		
0.005	45,896	15,750	15,750	26.46		
0.002	52,080	19,126	19,126	27.98		

[*] Top of levee stage

TABLE 3-25: ENGINEERING INPUTS—CENTRAL STOCKTON 01—2010 WITHOUT PROJECT

INDEX POINT D5						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0	0	3.18	4.10	0.0000
0.50	6,901	3,784	3,784	8.24	7.20	0.0869
0.20	15,360	9,487	9487	10.90	10.00	0.1872
0.10	21,654	9,934	9,934	11.10	13.20	0.2698
0.04	29,659	12,270	12,270	11.97	17.54[*]	0.4023
0.02	35,396	12,751	12,751	12.22	17.55	1.0000
0.01	40,815	15,346	15,346	13.07		
0.005	45,896	15,736	15,736	13.41		
0.002	52,080	19,117	19,117	15.53		

[*] Top of levee stage

TABLE 3-26: ENGINEERING INPUTS—CENTRAL STOCKTON 02—2010 WITHOUT PROJECT

INDEX POINT FR1						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0			8.14	0.0000
0.95	0	0	0	3.18	12.96	0.0663
0.50	21,899	1,776	1,776	7.33	15.90[*]	0.2537
0.10	79,122	7,774	7,774	11.75	18.84	0.5039
0.04	124,892	9,142	9,142	12.51	21.77[†]	0.7183
0.02	167,074	10,128	10,128	13.09	21.78	1.0000
0.01	216,499	13,869	13,869	14.65		
0.005	273,861	26,687	26,687	20.12		
0.002	363,117	32,943	32,943	21.98		

[*] Effective top of levee stage—elevation of natural upstream bank
[†] Top of levee stage

TABLE 3-27: ENGINEERING INPUTS—CENTRAL STOCKTON 03—2010 WITHOUT PROJECT

INDEX POINT CL2						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0	0	6.60	21.00	0.0000
0.50	6,901	3,848	3,848	19.13	25.50	0.0845
0.20	15,360	9,496	9,496	23.35	27.46	0.1719
0.10	21,654	9,861	9,861	23.58	29.40	0.2527
0.04	29,659	12,282	12,282	24.81	31.43[*]	0.3790
0.02	35,396	12,846	12,846	25.11	31.53	1.0000
0.01	40,815	15,359	15,359	26.29		
0.005	45,896	15,750	15,750	26.46		
0.002	52,080	19,126	19,126	27.98		

[*] Top of levee stage

TABLE 3-28: ENGINEERING INPUTS—RD17—WITHOUT PROJECT

INDEX POINT LR2						
ANNUAL CHANCE EXCEEDANCE	UNREGULATED-REGULATED TRANSFORM		DISCHARGE-STAGE RATING		FRAGILITY CURVE	
	Unregulated Flow (CFS)	Regulated Flow (CFS)	Regulated Flow (CFS)	Regulated Stage (ft)	Stage (ft)	*P* Of Failure
0.999	0	0	0	3.18	12.00	0.0000
0.50	21,899	1,771	1,771	7.60	17.00	0.1287
0.10	79,122	7,754	7,754	15.14	21.50	0.3839
0.04	124,892	9,143	9,143	16.47	24.65	0.5587
0.02	167,074	10,130	10,130	17.33	27.80*	0.6903
0.01	216,499	13,871	13,871	20.25	28.81	1.0000
0.005	273,861	15,734	15,734	22.96		
0.002	363,117	16,889	16,889	23.78		

* Top of levee stage

3.3 ANNUALIZED DAMAGES

Equivalent annual damages for the Lower San Joaquin study area are estimated to be approximately $314 million. Damages by consequence area and damage category are shown in Table 3-29 below.

TABLE 3-29: EQUIVALENT ANNUAL DAMAGES BY CONSEQUENCE AREA

CONSEQUENCE AREA	DAMAGE CATEGORY					
	AUTOS	COMMERCIAL	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
NORTH STOCKTON	14,000	25,000	1,000	8,000	133,000	181,000
CENTRAL STOCKTON	6,000	10,000	19,000	6,000	67,000	108,000
RD17	1,000	1,000	6,000	1,000	16,000	25,000
TOTAL	21,000	36,000	26,000	16,000	217,000	314,000

3.4 WITHOUT-PROJECT PERFORMANCE

In addition to estimating damages, HEC-FDA reports flood risk in terms of project performance. Three statistical measures are provided, in accordance with ER 1105-2-101, to describe performance risk in probabilistic terms. These measures are described below.

ANNUAL EXCEEDANCE PROBABILITY – The chance of having a damaging flood in any given year.

LONG-TERM RISK — The probability of having one or more damaging floods over a period of time.

ASSURANCE — The probability that a target stage will not be exceeded during a specified flood.

A project's performance can be an indicator of its short and long-term risk. However, because probability is only half of the risk equation, poor levee performance does not inherently mean high risk. Without-project performance of the highest risk levee in each impact area is shown below in Table 3-30. Complete performance statistics area provided in Attachment 6.

TABLE 3-30: PROJECT PERFORMANCE BY DAMAGE AREA

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.152	0.81	0.99	1.00	0.75	0.72	0.70	0.63	0.47	0.39
NS-03	0.152	0.81	0.99	1.00	0.80	0.77	0.75	0.71	0.62	0.58
NS-04	0.011	0.10	0.28	0.42	0.97	0.93	0.89	0.84	0.77	0.71
CS-01	0.120	0.72	0.98	1.00	0.78	0.76	0.74	0.72	0.68	0.65
CS-02	0.027	0.24	0.56	0.75	0.95	0.91	0.81	0.49	0.10	0.02
CS-03	0.017	0.15	0.39	0.57	0.95	0.92	0.89	0.85	0.80	0.76
RD17	0.021	0.19	0.47	0.66	0.93	0.87	0.79	0.68	0.56	0.52

3.5 FUTURE WITHOUT-PROJECT CONDITION

As discussed in Section 2.4, future sea level rise is expected to result in higher probabilities of flooding at certain index points. Table 3-31 compares expected annual damages and annual exceedance probability for existing and future without-project conditions for index points that are expected to be affected by sea level rise. Index points CL2, CR2, and SL2 are not expected to be impacted by sea level rise and are not included in this table.

TABLE 3-31: EXPECTED IMPACTS OF SEA LEVEL RISE

DAMAGE AREA	INDEX POINT	EXPECTED ANNUAL DAMAGES		ANNUAL EXCEEDANCE PROBABILITY	
		PRESENT YEAR	FUTURE YEAR	PRESENT YEAR	FUTURE YEAR
NS-02	D3	83,245	137,403	0.1519	0.2091
NS-03	D4	47,105	77,489	0.0646	0.0962
	D-BS	33,233	97,846	0.1521	0.189
CS-01	D5	59,363	93,309	0.1197	0.1582
	FR1	10,784	14,999	0.027	0.0415
CS-02	FR1	23,451	34,082	0.027	0.0415
RD17	FL1	12,266	17,680	0.0132	0.0202
	LR1	12,291	13,334	0.0126	0.0141
	LR2	22,766	27,749	0.0211	0.0257
	LR3	18,214	19,304	0.0095	0.0101
	LR4	3,716	3,779	0.0073	0.0075
	LRTB	16,903	17,074	0.0117	0.0075

CHAPTER 4 — ALTERNATIVE EVALUATION

4.1 INITIAL ARRAY OF ALTERNATIVES

An initial array of flood risk management alternative plans was developed, evaluated and compared to identify a plan that reasonably maximizes net benefits. This initial array of flood risk management alternative plans primarily consists of various upstream and downstream dry dam configurations, bypass alignments, setback levees, a ring levee, and channel modifications. Alternatives in the initial array were either screened out or retained based on parametric cost and benefit analysis

Each alternative in the initial array is summarized below. A summary of the alternatives carried forward to the focused array is shown in Table 4-1. Visual representations of each initial alternative can be found in Attachment 7 of this appendix.

4.1.1 NO ACTION ALTERNATIVE

This alternative would have no federal action identified. It would be expected that the future without-project assumptions would be maintained. It is expected that current flood risk management structures would be maintained and existing flood risk would remain.

4.1.2 NORTH STOCKTON ALTERNATIVES

North Stockton-A: Delta Front North and Fourteen Mile Slough. This alternative addresses the delta flooding source. This alternative includes a closure structure across Mosher Slough. This alternative covers 32,400 linear feet (6.136 miles) of levee. This alternative was screened out.

North Stockton-B: Delta Front North and South, and Calaveras River. This alternative addresses the delta and tidal portion of the Calaveras River as the flooding sources. The alternative includes a closure structure across Mosher Slough. The alternative covers a total 50,400 linear feet (9.545 miles) of levee. This alternative was carried forward.

North Stockton-C: Delta Front North. This alternative addresses the delta flooding source. This alternative includes closure structures across Mosher Slough and Fourteen Mile Slough. The alternative covers a total 23,700 linear feet (4.488 miles) of levee. This alternative was screened out.

North Stockton-D: Fourteen Mile Slough, Delta Front South, and Calaveras River. This alternative addresses the delta and tidal portion of the Calaveras River as the flooding sources. The alternative covers a total 42,300 linear feet (8.011 miles) of levee. This alternative was screened out.

North Stockton-E: Full Calaveras River. This alternative addresses the right bank of the Calaveras River as the flooding source. This alternative covers a total 41,900 linear feet (7.936 miles) of levee. This alternative was screened out.

North Stockton-F: Delta Front North and South, and Calaveras River. This alternative addresses the right bank of the Calaveras River and the delta front as flooding sources. This alternative includes closure structures across Mosher Slough and Fourteenmile Slough. This alternative covers a total 69,300 linear feet (13.125 miles) of levee. This alternative was carried forward.

4.1.3 CENTRAL STOCKTON ALTERNATIVES

Central Stockton-A: Calaveras and Diverting Canal. This alternative addresses the Stockton Diverting Canal and Calaveras River as flooding sources. The alternative covers a total 55,800 linear feet (10.568 miles) of levee. This alternative was screened out.

Central Stockton-B: Calaveras River. This alternative addresses the tidal portion of the Calaveras River and the San Joaquin River as sources of flooding and includes the Smith Canal closure structure. The alternative covers a total 19,000 linear feet (3.598 miles) of levee. This alternative was screened out.

Central Stockton-C: San Joaquin River Front. This alternative addresses the San Joaquin River, French Camp Slough, and Duck Creek as sources of flooding. The alternative covers a total 23,100 linear feet (10.189 miles) of levee. This alternative was screened out.

Central Stockton-D: Calaveras River, Diverting Canal, and San Joaquin River. This alternative addresses the San Joaquin River, Stockton Diverting Canal, Calaveras River, French Camp Slough and Duck Creek as flooding sources and includes the Smith Canal closure structure. The alternative covers a total 88,900 linear feet (16.837 miles) of levee. This alternative was carried forward.

Central Stockton-E: Calaveras River and Smith Canal. This alternative addresses the tidal portion of the Calaveras River and Smith Canal area as sources of flooding. The alternative covers a total 46,800 linear feet (8.864 miles) of levee. This alternative was screened out.

Central Stockton-F: Calaveras River and San Joaquin River. This alternative addresses the tidal portion of the Calaveras River, the San Joaquin River, French Camp Slough, and Duck Creek as flooding sources. The Smith Canal closure structure is also included. The alternative covers a total 51,600 linear feet (9.773 miles) of levee. This alternative was carried forward.

Central Stockton-G: Mormon Channel Bypass. This alternative develops a 1,200 cubic foot per second capacity diversion to the Mormon Channel from the Stockton Diverting Canal. The restoration of flows would affect 33,400 linear feet (6.326 miles) of channel. No levees are included. This alternative was screened out.

4.1.4 RECLAMATION DISTRICT 17 ALTERNATIVES

RD17-A: San Joaquin River North. This alternative addresses the San Joaquin River and French Camp Slough as the flooding sources. The alternative covers a total 77,000 linear feet (14.583 miles) of levee. This alternative was screened out.

RD17-B: San Joaquin River Tieback. This alternative addresses the San Joaquin River as the flooding source. The alternative covers a total 21,900 linear feet (4.148 miles) of levee. This alternative was screened out.

RD17-C: San Joaquin River North and Tieback. This alternative addresses the San Joaquin River and French Camp Slough as the flooding sources. The alternative covers a total 98,900 linear feet (18.731 miles) of levee. This alternative was screened out.

RD17-D: San Joaquin River Setback and Tieback. This alternative addresses the San Joaquin River as the flooding source, and includes a setback levee to limit protection of undeveloped floodplain within RD 17. The alternative covers a total 100,300 linear feet (18.996 miles) of levee. This alternative was screened out.

RD17-E: San Joaquin River North with Tieback and Extension. This alternative addresses the San Joaquin River and French Camp Slough as flooding sources. This alternative also extends the tie-back levee to address flanking issues. The alternative covers a total 106,900 linear feet (18.731 miles) of levee. This alternative was carried forward

RD17-F: Weston Ranch Ring Levee. This alternative addresses the San Joaquin River and French Camp Slough as flooding sources for Weston Ranch. The alternative includes new levee to form a ring levee around Weston Ranch, and an extension of RD 404 levees to prevent flanking during lower frequency events. The alternative covers a total 33,370 linear feet (6.3 miles) of levee. This alternative was screened out.

RD17-G: San Joaquin River Setback and Tieback Extension. This alternative addresses the San Joaquin River as the flooding source, and includes a setback levee to limit protection of undeveloped floodplain within RD 17. This alternative extends the tieback levee at the southern-most end of the reclamation district to minimize probability of flanking during extreme high water events. The alternative covers a total 113,500 linear feet (21.5 miles) of levee. This alternative was screened out.

TABLE 4-1: INITIAL ALTERNATIVES RETAINED

INCREMENT	ANNUAL BENEFITS	NET BENEFITS
North Stockton-B	72,000	53,000
North Stockton-F	76,000	54,000
Central Stockton-D	69,000	56,000
Central Stockton-F	56,000	46,000
RD17-E	27,000	12,000

4.2 FOCUSED ARRAY OF ALTERNATIVES

The project delivery team (PDT) used measures retained from the initial array to develop a focused array of alternatives. Each alternative in the focused array was evaluated on its performance relative to planning criteria set forth in USACE guidance, which states that the plan most reasonably maximizing net economic benefits is identified as the National Economic Development (NED) plan. A plan other than the NED Plan may be selected based on additional criteria but would require approval by the Assistant Secretary of the Army for Civil Works (ASA[CW]).

The following alternatives were evaluated as part of the focused array. Visual representations of each focused alternative can be found in Attachment 8 of this appendix.

4.2.1 NO ACTION

This alternative would have no federal action identified. It would be expected that the future without-project assumptions would be maintained. It is expected that current flood risk management structures would be maintained and existing flood risk would remain.

4.2.2 ALTERNATIVE 2a

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-F, Central Stockton-D, and RD 17-E. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The estimated extent of levee repairs would be approximately 53.14 miles (280,600 feet). This alternative was removed from consideration.

4.2.3 ALTERNATIVE 2b

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-B, Central Stockton-F, and RD 17-E. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The estimated extent of levee repairs would be approximately 42.5 miles (224,400 feet). This alternative was removed from consideration.

4.2.4 ALTERNATIVE 4

This alternative includes levee raises to meet SB 5 height requirements, where required, and also includes additional height increases for projected sea level and climate changes to the planning year 2070. The components of this plan are: North Stockton-B, Central Stockton-F, RD 17-E, and the Mormon Channel Bypass. The alternative would implement levee improvements along with restoration of the Mormon Channel including a diversion control structure at the Stockton Diverting Canal. The estimated extent of levee repairs and would be approximately 42.5 miles (224,400 feet) plus approximately 6.33 miles (33,400 feet) of channel work for the Mormon Channel portion. This alternative was removed from consideration.

4.2.5 ALTERNATIVE 7a

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-B and Central Stockton-F. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. The proposed levee improvements in this alternative are comparable to Alternative 7b, with the exception that the RD17 components are not included. This alternative was carried forward to the final array.

4.2.6 ALTERNATIVE 7b

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-B, Central Stockton-F, and RD 17-E. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. There would also be approximately 2.2 miles of new levee constructed to extend the RD-17 tie-back levee and the secondary levee at the Old River flow split. The new levees would also include a cutoff wall to address potential seepage issues. This alternative was carried forward to the final array.

4.2.7 ALTERNATIVE 8a

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-F and Central Stockton-D. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. The proposed levee improvements in this alternative are comparable to Alternative 8, with the exception that the RD17 components are not included. This alternative was carried forward to the final array.

4.2.8 ALTERNATIVE 8b

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-F, Central Stockton-D, and RD 17-E. The alternative would implement levee improvements without implementing either of the Mormon Channel or Paradise Cut bypasses. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. There would also be approximately 2.2 miles of new levee constructed to extend the RD-17 tie-back levee and the secondary levee at the Old River flow split. The new levees would also include a cutoff wall to address potential seepage issues. This alternative was carried forward to the final array.

4.2.9 ALTERNATIVE 9a

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-B, Central Stockton-F, and the Mormon Channel Bypass. The alternative would implement levee improvements along with restoration of the Mormon Channel including a diversion control structure at the Stockton Diverting Canal. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. The diversion control structure for Mormon Channel at the Stockton Diverting Canal would consist of pipe culverts with gates to control releases to a maximum flow of approximately 1,200 cubic feet per second to Mormon Channel. The proposed levee improvements in this alternative are comparable to Alternative 9b, with the exception that the RD17 components are not included. This alternative was carried forward to the final array.

4.2.10 ALTERNATIVE 9b

This alternative combines the following alternatives to arrive at a comprehensive solution: North Stockton-B, Central Stockton-F, RD 17-E, and the Mormon Channel Bypass. The alternative would implement levee improvements along with restoration of the Mormon Channel including a diversion control structure at the Stockton Diverting Canal. The alternative would combine the levee improvement measures of cutoff wall, deep soil mixing (seismic), seepage berm, and levee geometry improvements. In addition to the levee improvements, this alternative would address projected sea level change by including raises in levee height where needed. There would also be approximately 2.2 miles of new levee constructed to extend the RD-17 tie-back levee and the secondary levee at the Old River flow split. The new levees would also include a cutoff wall to address potential seepage issues. The diversion control structure for Mormon Channel at the Stockton Diverting Canal would consist of pipe culverts with gates to control releases to a maximum flow of approximately 1,200 cubic feet per second to Mormon Channel. This alternative was carried forward to the final array.

4.3 SCREENING OF THE FOCUSED ARRAY

Evaluation of each alternative in the focused array led to the selection of five alternatives to be included in the final array. A key component of the screening process was the consideration of potential sea level rise, which led to the elimination of alternatives 2A, 2B, and 4, none of which include measures that address sea level rise.

4.4 WITH-PROJECT DAMAGES

The residual damages and project benefits for each final alternative are summarized in Table 4-2**.**

TABLE 4-2: FINAL ARRAY OF ALTERNATIVES—RESIDUAL DAMAGES

ALTERNATIVE	RESIDUAL ANNUAL DAMAGES				ANNUAL BENEFITS	ANNUAL DAMAGE REDUCTION
	NORTH STOCKTON	CENTRAL STOCKTON	RD-17	TOTAL		
NO ACTION	181,000	108,000	25,000	314,000	0	-
LS-7a	4,000	21,000	25,000	50,000	264,000	84.1%
LS-8a	2,000	20,000	25,000	47,000	267,000	85.0%
LS-9a	4,000	21,000	25,000	50,000	264,000	84.1%
LS-7b	3,000	18,000	1,000	22,000	292,000	93.0%
LS-8b	1,000	16,000	1,000	18,000	296,000	94.3%
LS-9b	2,000	17,000	1,000	20,000	294,000	93.6%

4.5 WITH-PROJECT PERFORMANCE

Existing and future performance statistics for each of the alternative in the final array are shown in Tables 4-3 through 4-14.

TABLE 4-3: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-7A—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.009	0.00	0.01	0.01	1.00	1.00	1.00	0.99	0.95	0.92
NS-03	0.009	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.99	0.98
NS-04	0.009	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.99	0.98
CS-01	0.017	0.07	0.20	0.31	1.00	1.00	0.98	0.77	0.27	0.08
CS-02	0.015	0.07	0.20	0.31	1.00	1.00	0.98	0.77	0.27	0.08
CS-03	0.017	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
RD17	0.021	0.19	0.47	0.66	0.93	0.87	0.79	0.68	0.56	0.52

TABLE 4-4: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-7A—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.009	0.02	0.06	0.10	1.00	0.99	0.98	0.93	0.79	0.70
NS-03	0.009	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.99	0.98
NS-04	0.000	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.99	0.98
CS-01	0.017	0.08	0.21	0.32	1.00	1.00	0.97	0.74	0.24	0.07
CS-02	0.015	0.08	0.21	0.32	1.00	1.00	0.97	0.74	0.24	0.07
CS-03	0.017	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
RD17	0.026	0.23	0.54	0.73	0.92	0.84	0.77	0.67	0.55	0.52

TABLE 4-5: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-8A—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.000	0.00	0.01	0.01	0.999	0.999	0.999	0.99	0.95	0.92
NS-03	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
NS-04	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
CS-01	0.007	0.07	0.20	0.31	0.999	0.999	0.98	0.77	0.27	0.08
CS-02	0.007	0.07	0.20	0.31	0.999	0.999	0.98	0.77	0.27	0.08
CS-03	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.97
RD17	0.021	0.19	0.47	0.66	0.93	0.87	0.79	0.68	0.56	0.52

TABLE 4-6: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-8A—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	**30 YEARS**	**50 YEARS**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
NS-02	0.002	0.02	0.06	0.10	0.996	0.991	0.983	0.93	0.79	0.70
NS-03	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
NS-04	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
CS-01	0.008	0.08	0.21	0.32	0.999	0.999	0.97	0.74	0.24	0.07
CS-02	0.008	0.08	0.21	0.32	0.999	0.999	0.97	0.74	0.24	0.07
CS-03	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.97
RD17	0.026	0.23	0.54	0.73	0.92	0.84	0.77	0.67	0.55	0.52

TABLE 4-7: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-9A—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
NS-03	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
NS-04	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
CS-01	0.015	0.14	0.36	0.52	0.96	0.95	0.94	0.91	0.88	0.85
CS-02	0.011	0.10	0.28	0.42	0.97	0.94	0.92	0.89	0.84	0.80
CS-03	0.015	0.14	0.36	0.52	0.96	0.95	0.94	0.91	0.88	0.85
RD17	0.021	0.19	0.47	0.66	0.93	0.87	0.79	0.68	0.56	0.52

TABLE 4-8: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-9A—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
NS-03	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
NS-04	0.005	0.05	0.14	0.23	0.99	0.96	0.93	0.89	0.83	0.80
CS-01	0.015	0.14	0.36	0.52	0.96	0.95	0.94	0.91	0.88	0.85
CS-02	0.011	0.10	0.28	0.42	0.97	0.94	0.92	0.89	0.84	0.80
CS-03	0.015	0.14	0.36	0.52	0.96	0.95	0.94	0.91	0.88	0.85
RD17	0.026	0.23	0.54	0.73	0.92	0.84	0.77	0.67	0.55	0.52

TABLE 4-9: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-7B—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.009	0.10	0.28	0.42	0.97	0.93	0.89	0.84	0.78	0.71
NS-03	0.009	0.10	0.28	0.42	0.97	0.93	0.89	0.84	0.78	0.71
NS-04	0.009	0.10	0.28	0.42	0.97	0.93	0.89	0.84	0.78	0.71
CS-01	0.017	0.16	0.41	0.58	0.95	0.93	0.91	0.88	0.85	0.83
CS-02	0.015	0.15	0.39	0.57	0.95	0.92	0.89	0.85	0.80	0.76
CS-03	0.017	0.16	0.41	0.58	0.95	0.93	0.91	0.88	0.85	0.83
RD17	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.99

TABLE 4-10: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-7B—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.009	0.11	0.29	0.44	0.97	0.93	0.89	0.84	0.77	0.71
NS-03	0.009	0.11	0.29	0.44	0.97	0.93	0.89	0.84	0.77	0.71
NS-04	0.009	0.11	0.29	0.44	0.97	0.93	0.89	0.84	0.77	0.71
CS-01	0.017	0.17	0.43	0.60	0.95	0.93	0.91	0.88	0.85	0.83
CS-02	0.015	0.15	0.34	0.57	0.95	0.92	0.89	0.85	0.80	0.76
CS-03	0.017	0.17	0.43	0.60	0.95	0.93	0.91	0.88	0.85	0.83
RD17	0.001	0.01	0.04	0.06	0.999	0.999	0.995	0.955	0.86	0.82

TABLE 4-11: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-8B—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.999	0.999	0.999
NS-03	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
NS-04	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
CS-01	0.007	0.07	0.19	0.30	0.999	0.99	0.93	0.74	0.45	0.35
CS-02	0.007	0.07	0.19	0.30	0.999	0.99	0.93	0.74	0.45	0.35
CS-03	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.97
RD17	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.999	0.99	0.99

TABLE 4-12: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-8B—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.001	0.01	0.03	0.05	0.996	0.991	0.987	0.982	0.977	0.974
NS-03	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
NS-04	0.000	0.00	0.01	0.02	0.999	0.999	0.997	0.99	0.96	0.93
CS-01	0.012	0.11	0.30	0.45	0.993	0.95	0.83	0.59	0.32	0.23
CS-02	0.012	0.11	0.30	0.45	0.993	0.95	0.83	0.59	0.32	0.23
CS-03	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.97
RD17	0.001	0.01	0.04	0.06	0.999	0.999	0.995	0.955	0.86	0.82

TABLE 4-13: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-9B—PRESENT YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.005	0.05	0.15	0.24	0.99	0.95	0.92	0.88	0.82	0.78
NS-03	0.005	0.05	0.15	0.24	0.99	0.95	0.92	0.88	0.82	0.78
NS-04	0.005	0.05	0.15	0.24	0.99	0.95	0.92	0.88	0.82	0.78
CS-01	0.015	0.14	0.36	0.52	0.96	0.95	0.93	0.91	0.87	0.85
CS-02	0.007	0.07	0.19	0.30	0.999	0.99	0.93	0.74	0.45	0.35
CS-03	0.015	0.14	0.36	0.52	0.96	0.95	0.93	0.91	0.87	0.85
RD17	0.000	0.00	0.00	0.00	0.999	0.999	0.999	0.998	0.99	0.99

TABLE 4-14: PROJECT PERFORMANCE BY DAMAGE AREA—ALTERNATIVE LS-9B—FUTURE YEAR

DAMAGE AREA	ANNUAL EXCEEDENCE PROBABILITY	LONG-TERM RISK			ASSURANCE BY EVENT					
		10 YEARS	30 YEARS	50 YEARS	0.1	0.04	0.02	0.01	0.004	0.002
NS-02	0.005	0.06	0.17	0.27	0.99	0.95	0.92	0.88	0.82	0.77
NS-03	0.005	0.06	0.17	0.27	0.99	0.95	0.92	0.88	0.82	0.77
NS-04	0.005	0.06	0.17	0.27	0.99	0.95	0.92	0.88	0.82	0.77
CS-01	0.015	0.14	0.37	0.53	0.96	0.94	0.93	0.90	0.87	0.85
CS-02	0.012	0.11	0.30	0.45	0.993	0.95	0.83	0.59	0.32	0.23
CS-03	0.015	0.14	0.37	0.53	0.96	0.94	0.93	0.90	0.87	0.85
RD17	0.001	0.01	0.04	0.06	0.999	0.999	0.995	0.955	0.86	0.82

4.6 PROJECT COSTS

Project costs were estimated by USACE, Sacramento District's cost engineering section. Total first cost and construction duration for each alternative are shown in Tables 4-15 through 4-20 below. These estimates do not include interest during construction.

TABLE 4-15: FIRST COST ESTIMATE—ALTERNATIVE 7A

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$616,800
CENTRAL STOCKTON	2017	2020	$210,500
RD17	2017	2028	$0

TABLE 4-16: FIRST COST ESTIMATE—ALTERNATIVE 8A

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$669,400
CENTRAL STOCKTON	2017	2020	$291,500
RD17	2017	2028	$0

TABLE 4-17: FIRST COST ESTIMATE—ALTERNATIVE 9A

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$607,200
CENTRAL STOCKTON	2017	2020	$248,300
RD17	2017	2028	$0

TABLE 4-18: FIRST COST ESTIMATE—ALTERNATIVE 7B

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$599,700
CENTRAL STOCKTON	2017	2020	$204,000
RD17	2024	2030	$410,100

TABLE 4-19: FIRST COST ESTIMATE—ALTERNATIVE 8B

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$644,000
CENTRAL STOCKTON	2017	2020	$280,000
RD17	2024	2030	$410,000

TABLE 4-20: FIRST COST ESTIMATE—ALTERNATIVE 9B

FIX	START YEAR	END YEAR	TOTAL FIRST COST
NORTH STOCKTON	2018	2028	$594,000
CENTRAL STOCKTON	2017	2020	$242,000
RD17	2024	2030	$406,000

4.6.1 INTEREST AND BENEFITS DURING CONSTRUCTION

As delivered, the total project costs did not included interest during construction or benefits during construction.

Interest during construction (IDC) accrues each year between the start of construction and the base year. Total IDC is annualized over the period of analysis and added to the annual project cost.

Benefits during construction (BDC) are benefits that accrue annually between the year that one or more elements of the project begin to realize benefits and the base year. Total BDC is annualized over the period of analysis and added to the annual project benefits.

For this study, both IDC and BDC were calculated using the FY2014 discount rate of 3.5% and a 50 year period of analysis. Complete IDC and BDC calculations can be found in Attachment 9.

4.7 NET BENEFITS AND BENEFIT-TO-COST RATIO

Once benefit and cost calculations are complete, each alternative can be evaluated based on its net benefits (total return on investment) and benefit-to-cost ratio (return on each dollar invested). These metrics may provide the basis for decision-makers when selecting a plan. The net benefits and benefit-to-cost ratios for each final alternative are reported in Table 4-21.

TABLE 4-21: FINAL ARRAY OF ALTERNATIVES—ECONOMIC SUMMARY

ALTERNATIVE	RESIDUAL DAMAGES	ANNUAL BENEFITS*	ANNUAL COST†	NET BENEFITS	BENEFIT TO COST RATIO
NO ACTION	314,000	0	0	0	0
LS-7a	50,000	299,000	45,000	254,000	6.64
LS-8a	47,000	302,000	52,000	250,000	5.81
LS-9a	50,000	299,000	47,000	252,000	6.38
LS-7b	22,000	355,000	66,000	289,000	5.38
LS-8b	18,000	359,000	73,000	286,000	4.92
LS-9b	20,000	356,000	68,000	288,000	5.24

* Includes benefits during construction
† Includes interest during construction

ATTACHMENT 1: DESCRIPTION OF FLOOD SOURCES

Sacramento and San Joaquin Delta

The Sacramento and San Joaquin Delta covers more than 1,000 square miles of Central California. The delta is located at the confluence of the Sacramento and San Joaquin Rivers at the head of Suisun Bay, the most easterly extending arm of the San Francisco Bay system. In general, the Delta extends from about Sacramento on the north, to Stockton on the south, and near Pittsburg on the west. This region, which is very flat, has been reclaimed from a natural tidal area by hundreds of miles of levees along natural and manmade waterways that divide it into about 100 tracts locally know as "islands".

Before the islands were reclaimed, much of the Delta was covered by water from the daily tide cycle. During times of high runoff from the Sacramento and San Joaquin Basins, much of the Delta would be flooded. Reclamation of the many of the Delta islands has subjected the peat soils to oxidation. As a result, the interior of most islands have subsided well below sea level. Elevations within the islands now range from just above mean sea level to 10 feet below mean sea level.

Maximum stages within the Delta result from runoff from storms of different origins which do not have the same annual exceedance frequency at all locations, and from tides of varying magnitudes which seldom reach their maximum stages concurrently with the peak flows. In some years the annual maximum stage at all locations occurs during the same storm event. However, in other years, the peak stages in the northern part of the Delta occur during a different time period than those in the southern part of the Delta and vice versa. The differences are caused by the geographical distribution of the contributing drainage basin, antecedent conditions such as snowpack and soil moisture, and the fluctuation of the storm tracks over California. If the flood runoff is from the Sacramento River basin, the stages will be higher in the northern part of the Delta. If the main flood runoff is from the San Joaquin River, then the stages will be higher in the southern part of the Delta.

Several sloughs of the Delta including Five Mile Slough, Fourteen Mile Slough, and Ten Mile present significant flood risk to the study area. These sloughs have relatively small tributary areas and stages within the sloughs are primarily influenced by the combined tide and runoff from the Sacramento and San Joaquin Rivers.

San Joaquin River

The San Joaquin River is the principle stream in the southern half of the Central Valley of California. The San Joaquin is a perennial stream sustained through the summer by melting snow and releases from reservoirs. Its main headwater tributaries, the south and middle forks, rise in glacial lakes in the southern Sierra Nevada. They join at about elevation 3600 feet NAVD88 to form the main stem, which flows west-southwesterly to the valley floor, thence northwesterly down the main trough of the valley to the study area and its terminus at Suisun Bay. Upstream from the study area, the river is joined by several major tributaries flowing from the east and by a number of minor low elevation tributaries that flow from the east and west and have little effect on flood flows and stages. The major tributaries flowing from the east are the Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Less significant eastside tributaries comprise French Camp Slough (terminus of Duck and LittleJohns Creeks systems). The principal Westside tributaries are Panoche, Los Banos, San Luis, and Orestimba Creeks. Fresno Slough, a distributary of the Kings river that cuts through the valley-floor barrier ridge separating the Tulare Lake Basin from the San Joaquin River Basin proper, could contribute runoff to the San Joaquin River during extreme flood events.

Calaveras River

The Calaveras River is a tributary of the San Joaquin River. Elevations in the Calaveras River drainage vary from about 6,000 feet in the highest headwater areas to about 30 feet in the lower part of the study area. In the study area, the Calaveras River is distributary in nature, the stream divides into the north and south branches at Bellota, where a diversion of flow structure has been provided. The northern branch Calaveras River, flows westerly across the valley floor to join the San Joaquin River just west of Stockton. Very little flow enters this branch except during the summer when diversions are made for irrigation and ground-water replenishment. The southern branch, Mormon Slough, carries most of the flow. Its course extends in a general southwesterly direction from Bellota to the Stockton Diverting Canal flow diversion structure. The structure diverts all flood flows to the diverting canal which discharges into the Calaveras River. The Mormon Slough reach below the diverting dam is referred to locally as Mormon Channel. The source of flow in Mormon Channel is the local tributary area downstream of the diversion structure.

French Camp Slough

French Camp Slough is a tributary to the San Joaquin River south of the City of Stockton. The slough receives waters from Duck Creek and Littlejohn Creek. This slough, with or without upstream reservoirs has no effect on major flood flows in the San Joaquin River (USACE, 1955).

Duck Creek

Duck Creek is a small tributary of the French Camp Slough, south of the City of Stockton, lying between the Calaveras River-Mormon Slough system and Littlejohn Creek. It has a total drainage area of 54 square miles. Reduction of flood flow in the stream is accomplished by the Farmington Reservoir Project, which prevents overflow of Littlejohn Creek floodwater into Duck Creek, and the Duck Creek Diversion which diverts floodwater from upper Duck Creek into the improved channel of Littlejohn Creek. Approximately half of the Duck Creek drainage area lies above the Duck Creek Diversion Dam. The upstream area, about 28 square miles in extent, lies below 500 feet in elevation and is a typical foothill area, with an overall streambed slope of about 20 feet per mile. Downstream of the diversion structure the gently sloping flat valley floor is a poorly defined tributary drainage area. This creek, with or without upstream reservoirs has no effect on major flood flows in the San Joaquin River.

ATTACHMENT 2: DESCRIPTION OF RELATED FEDERAL FLOOD RISK MANAGEMENT PROJECTS

New Hogan Lake

New Hogan Lake was authorized by the Flood Control Act of 1944 (Public Law 534, December 22 1044, 78th Congress, 2nd Session). The project is located on the Calaveras River about 28 miles northeast of Stockton, Ca and comprises a rockfill dam with an impervious earth core and a maximum height of about 200 feet. The project also includes four dikes, with a maximum height of 18 feet, and a gated spillway to create a reservoir with a gross storage capacity of 325,900 acre-feet for flood control, irrigation and other water conservation purposes. Construction was initiated in May 1960, dam closure was made in November 1963, and the project was completed for operational use in June 1964.

Stockton and Mormon Channels (Diverting Canal)

Improvement of Stockton and Mormon Channels was authorized by the River and Harbor Act of June 13, 1902 (H. Doc. 152, 55th Congress, 3d Session, and Annual Report for 1899, p. 3188), to provide for diversion of the waters of Mormon Slough before reaching Mormon and Stockton Channels, for the purpose of preventing deposits of material in the navigable portions of Mormon and Stockton Channels and to divert flood flows past the city of Stockton, California. The results were obtained by construction of (1) a dam across Mormon Slough; (2) a diverting canal 150 feet wide, extending 4.63 miles to the north branch of the Calaveras River; (3) enlargement of the Calaveras River to cross-sectional area of 1,550 square feet, thence to its mouth at San Joaquin River, 5 miles; and (4) a levee along the left bank of the diverting canal and Calaveras River, using material excavated for the channel enlargement.

Construction of new work was initiated in November 1908; the initial construction phase was completed in September 1910. No further new work was accomplished until fiscal year 1922; the project was completed in fiscal year 1923. Most of the silt formerly deposited in Stockton and Mormon Channels is diverted by this canal, obviating serious inconveniences to navigation in the harbor area.

Federal maintenance of these channels for navigation purposes has been discontinued due to completion of levee and channel improvements constructed under provisions included in the Mormon Slough, Calaveras River, project authorized by the Flood Control Act of 1962 (Public Law 874, October 23, 1962, 87th Congress, 2d Session). No Federal maintenance costs have been incurred since Fiscal Year 1969. The project capacity was increased by the Mormon Slough project which was completed in 1971. The Mormon Slough project is described below.

Mormon Slough Project

The Mormon Slough project was authorized by the Flood Control Act of 1962 (Public Law 874, October 23, 1962, 87th Congress, 2nd Session). The project provides for the improvement of the Calaveras River system between the town of Bellota and the city of Stockton, California, and consists of minor channel enlargement of Mormon Slough between Bellota and Jack Tone Road; substantial channel enlargement of lower Mormon Slough and the Diverting Canal; new levees along the north bank of the Diverting Canal, along both banks of lower Mormon Slough, and along the south bank of Potters Creek between Jack Tone Road and Mormon Slough; and bank protection on lower Calaveras River levee. The project is an element of the comprehensive development of the Calaveras River basin, contains the flood flows which originate in the area downstream from New Hogan Reservoir and contains the flood control releases for efficient operation of that reservoir.

Preconstruction planning was initiated in January 1964. Construction was initiated in October 1967. Work was substantially completed in February 1970; remaining miscellaneous minor work was completed in December 1971. Project design flows are described in Table x.

Farmington Dam and Reservoir

Farmington Dam was authorized by the Flood Control Act of 1944 (Public Law, 534, December 22, 1944, 78th Congress, 2nd Session). The project is located on Littlejohn Creek about 2.5 miles upstream from Farmington and about 18 miles east of Stockton, California and consists of an earthfill dam, maximum height 58 feet, and an ungated saddle spillway, creating a reservoir gross storage capacity of 52,000 acre feet (USACE,1974).

Also included in the Farmington project were appurtenant facilities for diverting Duck Creek floodwaters to Littlejohn Creek. However, several of the appurtenant features were later updated by the Little Johns Creek and Calaveras River Stream Group Project and the Duck Creek Project. All facilities are for the exclusive purpose of flood management.

The Duck Creek diversion is located about 0.5 miles east of Farmington California and approximately 3.5 miles downstream from Farmington Dam. The diversion works consist of a low compacted earth dike across Duck Creek with on 72" gated and one 60" ungated outlet discharging into Duck Creek, and an ungated concrete spillway 73 feet long discharging into the diversion channel. According to exhibit B of the operations and maintenance manual, the 72" gate is to remain fully open unless closure is authorized or directed by the District Engineer, Sacramento District, Corps of Engineers (USACE, 1952).

The Duck Creek Diversion Unit also includes dike "B" built across the North Branch of Duck Creek approximately 4 miles downstream from the diversion works; and dike "C" built across the North Branch of Duck Creek approximately 9 miles downstream from the diversion works and just upstream from Jack Tone Road.

Construction was initiated in July 1949; the main dam and spillway were completed in June 1951; the Duck Creek channel improvements were completed in November 1951; and the downstream improvements along Littlejohn Creek were completed in May 1955. Enlargement of the Duck Creek channel downstream of the diversion structure as part of the later Duck Creek Project was authorized under Public Law 685, 84th Congress, 2nd Session. The Duck Creek project is described below.

Duck Creek Project

The Duck Creek Project is a small tributary of the San Joaquin River south of the City of Stockton, San Joaquin County, lying between the Calaveras River-Mormon Slough system and Littlejohn Creek. The Duck Creek Channel extends from the Duck Creek Diversion (Unit of the Farmington Project) located about 0.5 miles northeast of Farmington California and meanders downstream a distance of about 20 miles to French Camp Slough. Authority to improve the Duck Creek channel was approved by the Chief of Engineers under the small flood control project program authorized by Section 205 of the 1948 Flood Control Act as amended by Public Law 685, 84th Congress, 2nd Session. The project works consist of channel improvements along approximately 20 miles of the Duck Creek channel from 1/2 mile upstream of Escalon-Bellota Road to French Camp Slough. The project includes a short reach of levee on the lower end of Duck Creek along the left and right banks. The design flows are 700 cfs from the Diversion Dam to Mariposa Road and 900cfs below the diversion dam. Construction of the project was initiated May 1965 and completed by January 1967.

Lower San Joaquin River and Tributaries Project

Improvement of lower reaches of the San Joaquin River and Tributaries was authorized by the Flood Control Act of 1944 (Public Law 534, December 22, 1944, 78th Congress, 2nd Session), as modified by Public Law 327, 84th Congress, 1st Session). The project provided for improvement by the Federal Government of the existing channel and levee system on the San Joaquin River from the delta upstream to the mouth of Merced river, and on the lower reaches of the Stanislaus and Tuolumne Rivers, by raising and strengthening of existing levees, construction of new levees, revetment of river banks where required, and removal of accumulated snags in the main river channel. The project also provided for protection of flood plain areas about the mouth of Merced River through local interests construction of levee and channel improvements. The Upper Delta is defined roughly as that portion lying within the influence of flood flows while the lower Delta is that portion influenced mainly by tides. The line of demarcation is considered to be the downstream limits of the San Joaquin Flood Control Project and passes across the Delta from the confluence of the Stockton Deep water ship Channel and the San Joaquin River at the Port of Stockton, to Williams Bridge on Middle River, and to the junction of Paradise Cut and Salmon Slough with Grant Line Canal near Tracy.

The local interest plan of improvement was coordinated with that of the Federal Government to insure the effectiveness of the Federal portion of the projects. In addition to bearing the cost of improvements as required along the San Joaquin River upstream of the mouth of Merced River, Local interests were required for the Federal improvement downstream from Merced River, to furnish flowage rights to overflow certain lands along the San Joaquin River, to furnish all lands, easements, and rights-of-way for construction of improvement of levees; to accomplish all necessary utility alterations and relocations; to hold and save the United States free from damages due to the construction works and their subsequent maintenance and operation; and to maintain all levees and channel improvements after completion in accordance with regulations prescribed by the Secretary of the Army.

Federal construction was initiated in June 1956 and was completed in November 1968 except for the left bank levee along the San Joaquin River, Tuolumne to Merced River reach, which at that time was in the “inactive” category. This work was restored to “active” status on 25 June 1969 as required assurances of local cooperation for the reach were furnished after a change in land ownership. Contract for construction of this reach was initiated in November 1971 and completed in September 1972. The State of California has completed construction of the non-federal portion of the project above the mouth of the Merced River, comprising about 193 miles of new levees, including appurtenant features and about 80 miles of surfacing of existing levees.

Friant Dam

Friant Dam was authorized by the River and Harbor Act (Public Law No. 392) of August 26, 1937 (50 Stat. 850), and the River and Harbor Act of October 17, 1940 (ch 895, 54 Stat. 1198, 1199) extended the authorization to include irrigation distribution systems. The project is located about 25 miles northeast of Fresno and an equal distance east of Madera. It is a concrete gravity structure, 319 feet high and 3,488 feet long at the crest. The spillway is 332 feet wide and is located near the center of the dam. It has three 100 by 18-foot drum gates and a discharge capacity of 83,000 cfs at gross pool elevation.

Initial construction was started in October of 1939 and was completed in November 1942. Work deferred during the war, including spillway gates, outlet valves, Friant-Kern Canal stilling basin, etc., was again started in March of 1946 and the project was completed for operation in 1949.

Big Dry Creek Dam

Big Dry Creek Dam was authorized by the Flood Control Act of 1941 (Public Law 288, August 18, 1941, 77th Congress, 1st Session). The project is located about 10 miles northeast of Fresno, California, and about 4 miles northeast of Clovis, California and comprises and earthfill dam across the channel of Big Dry Creek, with a maximum height of 40 feet, creating a reservoir with a maximum capacity of 16,250 acre-feet, all for flood control, together with appurtenant diversion facilities both upstream and downstream from the dam. Construction of the project was initiated in April 1947 and completed in February 1948. Construction of remedial work consisting of erosion control structures to control side-hill erosion was initiated in October 1952 and completed in March 1955.

Comanche Dam

Federal participation in the construction of Comanche Dam was authorized by the Flood Control Act of 1960 (Public Law 86-645, 14 July 1960, 86th Congress, 2d Session). Comanche Dam and Reservoir is a multiple-purpose dam and reservoir on the Mokelumne River about 20 miles northeast of Stockton. The dam and reservoir was constructed by the East Bay Municipal Utility District which owns and operates the project facilities. Federal interest in the project is in the flood protection afforded by the dam and reservoir commensurate with the flood control benefits to be derived. The project comprises a rock fill dam with impervious earth core, maximum height 171 feet, together with six dikes totaling 19,250 feet in length and a gated spillway, creating a reservoir gross storage capacity of 431,500 acre-feet for flood control and water supply.

In consideration of the Federal contribution toward the first cost of Comanche Reservoir, the East Bay Municipal Utility District provides a flood-control reservation of 200,000 acre-feet, under an agreement with the Department of the Army providing for operation of the reservoir in such manner as will produce the flood-control benefits upon which the monetary contribution is predicated, and will operate the flood-control reservation in accordance with the rules and regulations prescribed by the Secretary of the Army.

The cost allocation for the project was approved by the President on 9 March 1962. Contract for Federal payment for flood control benefits to be attained was consummated 19 March 1962 with the East Bay Municipal Utility District and approved by the Secretary of the Army 19 April 1962. Contract for construction of the main dam and appurtenances was awarded in March 1962; dam closure was completed 7 November 1963. The project was operationally completed in April 1964.

Los Banos Dam

Los Banos Dam was authorized by the Central Valley Project, California Act of 1960 (Public Law 488, June 3, 1960, 86th Congress, 2nd Session) and was constructed by the US Bureau of Reclamation, with funds contributed in part by the Federal Government in the interest of flood control, and are operated by the State of California. The project is located on Los Banos Creek, a west side tributary to San Joaquin River, approximately seven miles southwest of the small city of Los Banos in Merced County, California and comprises of a earthfill dam, with a maximum height of 167 feet, creating a reservoir with a maximum capacity of 34,600 acre-feet, most of which is for flood protection, with a provision of a pool for recreation and other purposes. There is also an uncontrolled concrete chute spillway located in the left abutment of the dam with a discharge capacity of 8,600 cfs.Outlet works, including an intake structure, conduit, emergency gate, and control gates are located in the left abutment of the dam and discharge the water into a stilling basin which, in turn, empties into the existing channel of Los Banos Creek downstream from the structure. Construction of the project began in May 1964 and completed by November 1965.

New Exchequer Dam

New Exchequer Dam was authorized by the Flood Control Act of 1960 (Public Law 645, July 14^{th}, 1960, 86^{th} Congress, 2^{nd} Session). The project is located in the southern half of the Central Valley in Mariposa County, California. It is on the Merced River about 60 miles above its confluence with the San Joaquin River. New Exchequer Dam and Reservoir were constructed for the purposes of irrigation, power, recreation, and flood control providing. The reservoir includes a maximum of 400,000 acre-feet of flood control space. New Exchequer Reservoir has a capacity of 1,024,600 acre-feet. The dam is a rockfill dam, concrete faced with a height of 490 feet and is located immediately downstream from the old concrete Exchequer Dam, which is incorporated into the upstream toe of the embankment. A dike of similar gravel fill construction is located about ¾ of a mile northwest of New Exchequer Dam. A spillway, located approximately one mile northwest of the right abutment of New Exchequer Dam consists of a gated spillway and an ungated emergency spillway, each with a concrete ogee crest. The total combined discharge capacity of the gated and emergency spillways is 375,000 cfs. The outlet works consists of a single conduit under the right abutment of both the old and new portions of the dam.   Construction of the project was initiated in June 1964 and completed in December 1967.

Don Pedro Dam

Don Pedro Dam was authorized by the Flood Control Act of 1944 (Public Law 534, December 22^{nd}, 1944, 78^{th} Congress, 2^{nd} Session). The project is located on the Toulumne River about 35 miles east of Modesto. The dam is a combination rock and earthfill dam with a maximum height of 585 feet and a total capacity of 2,030,000 acre-feet which is primarily to store irrigation water and has additional benefits including power generation, flood control, and recreation. A spillway located on the abutment ridge west of the dam, consists of both a gated spillway and an ungated emergency spillway, each with a long concrete ogee section. The total combined discharge capacity of the spillway is 472,500 cfs. The outlet works is located in a concrete plug centered approximately on the axis of the dam. Three separate parallel outlets are provided, each controlled by two high-pressure slide gates in tandem. The combined capacity of the three outlets is 7,370 cfs. Construction of the project was initiated in August 1967 and completed in March 1971.

Buchanan Dam

Buchanan Lake was authorized by the Flood Control Act of 1962 (Public Law 874, 23 October 1962, 87th Congress, 2d Session). The project provides for construction of a dam on Chowchilla River, about 16 miles northeast of the city of Chowchilla, California, to create a reservoir with gross storage capacity of about 150,000 acre-feet for flood control, irrigation, recreation, and other purposes. The project plan provides for approximately 20 miles of levee and channel improvements along Ash and Berenda Sloughs, distributaries of Chowchilla River. Construction of the project was initiated in June 1972 and completed in June 1978.

Hidden Dam and Lake

Hidden Dam and Lake was authorized by the Flood Control Act of 1962 (Public Law 874, 23 October 1962, 87th Congress, 2d Session). The project provides for construction of a dam on Fresno River, about 15 miles northeast of Madera, California, to create a reservoir with gross storage capacity of about 90,000 acre-feet for flood control, irrigation, recreation, and other purposes. The project plan as authorized also provides for approximately 13.3 miles of levee and channel improvements on Fresno River downstream from the dam site. Construction of the project was initiated in June 1972 and completed in June 1978.

New Melones Dam

New Melones Lake was authorized by the Flood Control Act of 1944 (Public Law 534. December 22, 1944. 78th Congress, 2d Session), as modified by the Flood Control Act of 1962 (Public Law 874, October 23, 1962, 87th Congress, 2d Session). The project is located on Stanislaus River, about 35 miles northeast of Modesto, California. The project plan provides for construction of a 625 foot high earth and rockfill dam to create a reservoir with a gross storage capacity of 2,400,000 acre-feet for flood control, irrigation, power, recreation, fish and wildlife and water quality control. The plan of improvement also includes construction of a 300,000 KW capacity hydroelectric power plant immediately below the dam. Construction of the project was initiated in 1966 and completed in October 1978.

ATTACHMENT 3: 2011 INVENTORY DEVELOPMENT

Data Cleaning

Tax assessor data containing geospatially referenced land parcel information was reviewed in preparation for the structure inventory described in task three below. This data included the address, geospatial location, square footage and land use for each parcel located in the Lower San Joaquin Dam break floodplain maps. Problematic data such as duplicate entries and missing observations were identified and corrected or deleted in order to facilitate unbiased sampling and structure valuation work.

Create Samples and Inventory Maps

Stratified random samples containing properties to be included in the structure inventory were generated using. Samples were stratified according to land use type. Land use type data taken from the tax assessor dataset. Sample sizes were chosen based on the number of working days allotted for the structure inventory. Once all the properties included in the structure inventory had been selected a driving route for the inventory was created using Google Fusion Tables.

Performed Structure Characteristics Survey

Four Economists (in two vehicles) surveyed 833 separate parcels based upon observations from the nearest accessible public road or access point. Parcels were located using addresses and geospatial references on Google Maps as needed and seven characteristics were assessed: bad address, first floor elevation, stories, construction class, construction quality, condition, and Marshall & Swift Use (MS Use) category. A parcel is marked as a bad address if no structure is present or the parcel cannot be located. First floor elevation is the elevation in half-foot increments from the bottom of the front doorway to ground level. Stories are the number of stories in the surveyed structures. Construction class, quality, condition and MS Use follow guidance from the *Marshall Valuation Service* and in all cases were limited to exterior surveys of the structure. Construction class is the type of framing, walls, floors and roof structures, and fireproofing. Class is represented by B, C, D or S. Construction quality is judged by materials, workmanship, and complexity and is represented by Low Cost, Fair, Average, Good, Very Good, and Excellent. Condition is the level of accumulated depreciation apparent to the structure exterior, which is also used as a proxy for interior depreciation and is represented by Dilapidated, Poor, Fair, Average, Good, Very Good, and Excellent. The MS Use category is the apparent structure function or use based on indicators such as signage, other structure uses in the vicinity, building type, etc. It is represented by distinct uses that captured the generic function of all the structures surveyed. See *Marshall Valuation Service* for further details.

Performed Structure Square Footage Survey

The majority of commercial, industrial, and public parcels in the assessor's database did not have square footage. A number of these parcels did in fact have structures. However, structure values for these structures were estimated directly and therefore, no adjustment the tax assessor square footage data was necessary. Most of the residential structures had square footage; however, the square footage needed to be tested for accuracy. To accomplish this aerial surveys were performed using GIS and Google Earth Pro. Structures were randomly sampled from the surveyed parcels shown to have structures present in Step 3. Since aerial resolution in GIS was judged to be insufficient for accurate square footage estimates, it was used to verify the location of parcels only. Google Earth Pro has superior image resolution and was used to make the square footage measurements by calculating the area of a polygon that traces the roof line of the structure. Structure square footage estimates taken from tax assessor data and aerial surveys were relatively similar. Therefore no adjustment was made to tax assessor square footage estimates.

Applied Characteristics to Non-Surveyed Parcels

Survey results showed substantial errors in the assessor's data on broad use category (Residential, Commercial, Industrial, Agricultural, and Public) and whether a structure is present on the parcel (i.e., zero vs. nonzero square footage. The following steps were taken to address these errors and to apply the survey characteristics to the non-sampled data.

> **SEPARATED SURVEY DATA BY ZERO/NONZERO SQUARE FOOTAGE** - This was done to create separate distributions for these two types of parcels under the assumption that parcels listed with positive square footage and parcels listed with zero square footage are systematically different on average. For instance, during the surveys we noticed that some recent housing developments contained finished or nearly-finished structures that were assigned zero square footage by the assessor. To account for this and other potential systematic differences a separate distribution of characteristics was made for non-surveyed parcels the assessor listed with zero and nonzero square footage (i.e., without and with a structure on the parcel).
>
> **ADJUSTED BROAD USE CATEGORY** – The surveyed broad use category was compared to the assessor broad use category. The assessor broad use category was adjusted based on survey results. For instance, among 190 surveyed parcels the assessor data labeled commercial (and with zero square footage), only 82% were demonstrated to be commercial properties during the survey. The remaining 18% were industrial, public, or residential. Therefore, 18% of the non-surveyed parcels labeled commercial by the assessor were randomly adjusted to be industrial, public, or residential. This broad use adjustment was made to all the non-surveyed parcels.
>
> **ADJUSTED STRUCTURE COUNT** - As explained in step I, the surveyed parcels were separated into nonzero and zero square footage. Alternatively, these can be thought of as parcels with and without square footage. Most parcels we surveyed that the assessor labeled with square footage (nonzero square feet) had a structure present. Parcels the assessor labeled without square footage (zero square feet) sometimes had a structure and sometimes did not. The share that did have a structure versus the share that did not were calculated and these two percentages were used to randomly reduce the number of non-sampled parcels that the assessor incorrectly labeled without a structure (i.e. zero square footage). Likewise, a small number of non-sampled parcels with square footage in the assessor's records were removed from the population, based on

percentage of sampled parcels the assessor incorrectly labeled as having a structure (i.e. positive square footage).

ADJUSTED CHARACTERISTICS – Characteristics of the surveyed structures were applied to the non-survey structures. @Risk was used to assign a number of stories to each non-sampled structure. The @Risk number of stories simulations were based strata specific (broad category) sampled structure number of stories probability distributions. Each non-sampled structure was the average first floor elevation of the strata to which it belongs. However, a triangular first floor elevation distribution was entered into HEC-FDA, based on the survey results. As a result the (average) first floor elevation assigned to each non-sampled structure in the database will vary (based on this triangular distribution) in each HEC-FDA simulation.

STRUCTURE VALUE – Non-sampled structures were each assigned a structure value. Non-sampled structures with a square footage entry (based on tax assessor records and task 5.I. above) were assigned a structure value equal to the product of the square footage entry and the within strata (broad category) average per square foot structure value. Non-sampled structures without square footage entries were assigned the within strata average structure value. Again, a triangular distribution, based on the sampled distribution, was entered into HEC-FDA. Thus each structure's value will vary in each HEC-FDA simulation, based on this triangular distribution.

Valued Structures and Contents

Once the non-surveyed parcels were assigned the characteristics from the survey results, per square foot depreciated replacement costs for each structure were determined. This per square foot depreciated structure replacement cost was then applied to each structure's recorded square footage to obtain its depreciated structure replacement cost. Structure content were calculated using the following ratios: Residential structure contents were valued at 50% of the structure value; Industrial, commercial, agricultural and public structure contents were valued using the methodology described in *Analysis of Nonresidential Content-to-Structure Ratios and Depth-Damage Functions for Flood Damage Reduction Studies*. Using this method structure contents are a ratio of structure value that varies by structure use category.

Prepared Data for HEC-FDA

The content-to-structure ratios and content depth damage curves were taken from *Analysis of Nonresidential Content-to-Structure Ratios and Depth-Damage Functions for Flood Damage Reduction Studies* and set up in a spreadsheet consistent with guidance from the *HEC-FDA User Manual* dated November 2008. To account for risk and uncertainty, error values were included in the HEC-FDA import spreadsheet file.

> **CONTENT-TO-STRUCTURE RATIO ERROR** — TAKEN from Analysis of Nonresidential Content-to-Structure Ratios and Depth-Damage Functions for Flood Damage Reduction Studies
>
> **STRUCTURE VALUATION ERROR** – triangular distribution based on the distribution of sampled structure values.
>
> **FIRST-FLOOR ELEVATION ERROR** – triangular distribution based on the distribution of sampled structure values.

Key Assumptions

- Since interior housing characteristics could not be observed, external and observable characteristics were only used to assess the surveyed structures and assign structure valuations.
- First floor elevation, stories, construction class, construction quality, condition, and Marshall & Swift Use (MS Use) category completely and accurately define the characteristics of the surveyed structures necessary to estimate depreciated value per square foot.
- Observations were unbiased in a manner that would not lead to upward or downward depreciated structure valuations on average.
- Roof line profile measured from aerial imagery approximates actual structure square footage but is slightly upwardly biased due to roof overhangs, contiguous porch area, etc. Thus tax assessor records with square footage entries within ~25% of aerial square footage estimates are approximately equivalent.
- Parcels the assessor listed with a structure are systematically different from parcels the assessor listed without a structure. This assumption appears correct because the distribution of characteristics between the two parcel types are noticeably different for most broad use categories.
- The surveyed structures were representative of the non-surveyed structures across all characteristics evaluated and the sample sizes were sufficient to extrapolate surveyed characteristics to the non-surveyed parcels.
- Structure value is not correlated with depth of flooding.
- Content value varies proportionally with structure value and, on average, is equal to a fixed percentage of structure value

The three error terms—content-to-structure error, structure valuation error, first-floor elevation error—adequately address the risk and uncertainty inherent in this model.

ATTACHMENT 4: DEPTH-PERCENT DAMAGE CURVES

DEPTH-PERCENT DAMAGE FOR STRUCTURES BY OCCUPANCY TYPE

OCCUPANCY TYPE	INUNDATION DEPTH IN FEET																			
	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Automobiles	0%	0%	0%	2.8%	21.8%	31.2%	40.5%	56.9%	71.1%	83.2%	91.9%	96.1%	99.2%	100%	100%	100%	100%	100%	100%	100%
Commercial Auto Sales 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Auto Sales 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Fast Food Rest 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Fast Food Rest 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial FoodRetail 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial FoodRetail 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Grocery Store 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Grocery Store 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Medical 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Medical 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Office 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Office 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Restaurants 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Restaurants 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Retail 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Retail 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial ServiceAuto 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial ServiceAuto 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Commercial Shopping Center 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Commercial Shopping Center 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Farm Buildings Including Residence	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Full Service Auto Dealership 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Full Service Auto Dealership 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Furniture Store 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Furniture Store 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Hospital 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Hospital 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Hotel 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Hotel 2-story	2.6%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Industrial Heavy Manufacture 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Industrial Heavy Manufacture 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Industrial Light 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Industrial Light 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Industrial Warehouse 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Industrial Warehouse 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Mobile Home Single/Double	6.4%	7.3%	9.9%	43.4%	44.7%	45.0%	45.7%	45.9%	50.0%	65.6%	65.6%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%	66.0%
MultiFamily Residential 1-story	2.5%	8.0%	13.4%	18.4%	23.3%	27.7%	32.1%	40.1%	47.1%	53.2%	58.6%	63.2%	67.2%	70.5%	73.2%	75.4%	77.2%	78.5%	79.5%	80.2%
MultiFamily Residential 2-story	3.0%	6.2%	9.3%	12.3%	15.2%	18.1%	20.9%	26.3%	31.4%	36.2%	40.7%	44.9%	48.8%	52.4%	55.7%	58.7%	61.4%	63.8%	65.9%	67.7%
Public and Private Schools 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Public and Private Schools 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Public Church 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Public Church 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Public Government Building 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Public Government Building 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Public Recreation/Assembly 1-story	0%	3.5%	7.0%	11.7%	16.3%	20.5%	24.7%	27.7%	29.6%	30.9%	39.8%	42.8%	43.3%	44.8%	45.8%	47.0%	47.3%	48.2%	48.8%	49.9%
Public Recreation/Assembly 2-story	0%	1.3%	2.5%	3.8%	5.0%	7.6%	10.1%	15.3%	17.1%	18.9%	21.5%	22.8%	22.8%	24.1%	26.1%	40.4%	43.3%	46.2%	46.2%	49.1%
Single Family Residential 1-story	2.5%	8.0%	13.4%	18.4%	23.3%	27.7%	32.1%	40.1%	47.1%	53.2%	58.6%	63.2%	67.2%	70.5%	73.2%	75.4%	77.2%	78.5%	79.5%	80.2%
Single Family Res 1-story w/bsmt	19.4%	22.5%	25.5%	28.8%	32.0%	35.4%	38.7%	45.5%	52.2%	58.6%	64.5%	69.8%	74.2%	77.7%	80.1%	81.1%	81.1%	81.1%	81.1%	81.1%
Single Family Residential 2-story	3.0%	6.2%	9.3%	12.3%	15.2%	18.1%	20.9%	26.3%	31.4%	36.2%	40.7%	44.9%	48.8%	52.4%	55.7%	58.7%	61.4%	63.8%	65.9%	67.7%
Single Family Res 1-story w/bsmt	13.9%	15.9%	17.9%	20.1%	22.3%	24.7%	27.0%	31.9%	36.9%	41.9%	46.9%	51.8%	56.4%	60.8%	64.8%	68.4%	71.4%	73.7%	75.4%	76.4%
Single Family Residential Split Level	6.4%	6.8%	7.2%	8.3%	9.4%	11.2%	12.9%	17.4%	22.8%	28.9%	35.5%	42.3%	49.2%	56.1%	62.6%	68.6%	73.9%	78.4%	81.7%	83.8%
Single Family Res 1-story w/bsmt	14.2%	16.4%	18.5%	20.9%	23.2%	25.7%	28.2%	33.4%	38.6%	43.8%	48.8%	53.5%	57.8%	61.6%	64.8%	67.2%	68.8%	69.3%	69.3%	69.3%

Depth-Percent Damage for Contents by Occupancy Type

OCCUPANCY TYPE	INUNDATION DEPTH IN FEET																			
	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Automobiles	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Commercial Auto Sales 1-story	0%	0%	0%	18.1%	34.9%	59.2%	78.4%	90.4%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Auto Sales 2-story	0%	0%	0%	15.5%	29.3%	40.7%	49.8%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Fast Food Rest 1-story	0%	0%	0%	12.0%	23.3%	38.6%	59.4%	90.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Fast Food Rest 2-story	0%	0%	0%	10.1%	19.6%	26.5%	37.7%	49.7%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial FoodRetail 1-story	0%	0%	0%	15.8%	29.3%	43.1%	72.2%	96.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial FoodRetail 2-story	0%	0%	0%	13.3%	24.6%	29.7%	45.8%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Grocery Store 1-story	0%	0%	0%	17.6%	32.0%	47.6%	69.8%	88.6%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Grocery Store 2-story	0%	0%	0%	14.8%	26.9%	32.8%	44.4%	48.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Medical 1-story	0%	0%	0%	16.8%	33.5%	51.3%	72.8%	88.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Medical 2-story	0%	0%	0%	14.1%	28.1%	35.3%	46.3%	48.9%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Office 1-story	0%	0%	0%	18.1%	34.9%	59.2%	78.4%	90.4%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Office 2-story	0%	0%	0%	15.5%	29.3%	40.7%	49.8%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Restaurants 1-story	0%	0%	0%	15.0%	29.6%	52.6%	77.3%	96.1%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Restaurants 2-story	0%	0%	0%	12.6%	24.8%	36.2%	49.1%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Retail 1-story	0%	0%	0%	69.3%	80.4%	86.8%	95.0%	96.5%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Retail 2-story	0%	0%	0%	14.0%	19.1%	25.1%	31.5%	35.7%	45.1%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial ServiceAuto 1-story	9.1%	9.1%	9.9%	17.7%	23.2%	37.5%	42.8%	67.4%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial ServiceAuto 2-story	7.6%	7.6%	8.3%	14.8%	19.5%	25.8%	27.2%	37.1%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Commercial Shopping Center 1-story	0%	0%	0%	20.5%	32.8%	47.6%	58.5%	71.9%	97.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Commercial Shopping Center 2-story	0%	0%	0%	17.2%	27.5%	32.7%	37.2%	39.6%	48.6%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Farm Buildings Including Residence	0%	0%	0%	12.9%	30.1%	42.8%	56.0%	75.6%	99.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Full Service Auto Dealership 1-story	5.3%	5.3%	5.8%	16.2%	25.3%	41.2%	52.1%	72.0%	96.2%	99.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Full Service Auto Dealership 2-story	4.4%	4.4%	4.8%	13.6%	21.3%	28.3%	33.1%	39.6%	48.1%	49.5%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Furniture Store 1-story	0%	0%	0%	69.3%	80.4%	86.8%	95.0%	96.5%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Furniture Store 2-story	0%	0%	0%	35.8%	41.5%	44.8%	49.1%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Hospital 1-story	0%	0%	0%	16.8%	33.5%	51.3%	72.8%	88.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Hospital 2-story	0%	0%	0%	14.1%	28.1%	35.3%	46.3%	48.9%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Hotel 1-story	0%	0%	0%	12.0%	23.3%	38.6%	59.4%	90.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Hotel 2-story	0%	0%	0%	12.6%	24.8%	36.2%	49.1%	49.8%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Industrial Heavy Manufacture 1-story	0%	0%	0%	5.8%	16.1%	28.9%	41.0%	56.4%	85.4%	92.5%	97.1%	98.1%	98.1%	99.1%	100%	100%	100%	100%	100%	100%
Industrial Heavy Manufacture 2-story	0%	0%	0%	4.9%	13.6%	19.9%	26.0%	31.1%	42.7%	46.2%	48.6%	49.1%	49.1%	49.5%	50.0%	59.6%	72.3%	96.3%	100%	100%
Industrial Light 1-story	0%	0%	0%	19.1%	35.2%	48.9%	64.2%	74.8%	91.8%	96.3%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Industrial Light 2-story	0%	0%	0%	16.0%	29.6%	33.6%	40.8%	41.2%	45.9%	48.1%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Industrial Warehouse 1-story	0%	0%	0%	11.3%	23.4%	36.5%	54.9%	69.0%	84.2%	95.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Industrial Warehouse 2-story	0%	0%	0%	9.5%	19.6%	25.1%	34.8%	38.0%	42.1%	47.8%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Mobile Home Single/Double	0%	0%	0%	28.1%	38.3%	44.8%	56.4%	68.6%	79.9%	89.6%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%
MultiFamily Residential 1-story	2.4%	5.3%	8.1%	10.7%	13.3%	15.6%	17.9%	22.0%	25.7%	28.8%	31.5%	33.8%	35.7%	37.2%	38.4%	39.2%	39.7%	40.0%	40.0%	40.0%
MultiFamily Residential 2-story	1.0%	3.0%	5.0%	6.9%	8.7%	10.5%	12.2%	15.5%	18.5%	21.3%	23.9%	26.3%	28.4%	30.3%	32.0%	33.4%	34.7%	35.6%	36.4%	36.9%
Public and Private Schools 1-story	0%	0%	0%	12.6%	21.9%	33.4%	47.3%	66.7%	76.1%	87.8%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Public and Private Schools 2-story	0%	0%	0%	10.6%	18.4%	23.0%	30.1%	36.8%	38.0%	43.9%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Public Church 1-story	0%	0%	0%	22.7%	32.9%	45.8%	74.8%	85.5%	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%	99.3%	100%	100%	100%
Public Church 2-story	0%	0%	0%	19.1%	27.6%	31.5%	47.1%	47.1%	49.4%	49.4%	49.4%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Public Government Building 1-story	0%	0%	0%	18.1%	34.9%	59.2%	78.4%	90.4%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Public Government Building 2-story	0%	0%	0%	15.7%	30.1%	42.1%	49.9%	49.9%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	71.2%	96.2%	100%	100%
Public Recreation/Assembly 1-story	0%	0%	0%	24.5%	37.8%	57.3%	74.6%	94.7%	98.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Public Recreation/Assembly 2-story	0%	0%	0%	20.6%	31.7%	39.4%	47.1%	49.0%	49.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	59.6%	72.3%	96.3%	100%	100%
Single Family Residential 1-story	2.4%	5.3%	8.1%	10.7%	13.3%	15.6%	17.9%	22.0%	25.7%	28.8%	31.5%	33.8%	35.7%	37.2%	38.4%	39.2%	39.7%	40.0%	40.0%	40.0%
Single Family Res 1-story w/bsmt	13.2%	14.6%	16.0%	17.5%	18.9%	20.4%	21.8%	24.7%	27.4%	30.0%	32.4%	34.5%	36.3%	37.7%	38.6%	39.1%	39.1%	39.1%	39.1%	39.1%
Single Family Residential 2-story	1.0%	3.0%	5.0%	6.9%	8.7%	10.5%	12.2%	15.5%	18.5%	21.3%	23.9%	26.3%	28.4%	30.3%	32.0%	33.4%	34.7%	35.6%	36.4%	36.9%
Single Family Res 1-story w/bsmt	10.1%	11.0%	11.9%	12.9%	13.8%	14.8%	15.7%	17.7%	19.8%	22.0%	24.3%	26.7%	29.1%	31.7%	34.4%	37.2%	40.0%	43.0%	46.1%	49.3%
Single Family Residential Split Level	2.2%	2.6%	2.9%	3.8%	4.7%	6.1%	7.5%	11.1%	15.3%	20.1%	25.2%	30.5%	35.7%	40.9%	45.8%	50.2%	54.1%	57.2%	59.4%	60.5%
Single Family Res 1-story w/bsmt	9.4%	10.5%	11.6%	12.7%	13.8%	15.0%	16.1%	18.2%	20.2%	22.1%	23.6%	24.9%	25.8%	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%	26.3%

ATTACHMENT 5: WITHOUT-PROJECT ENGINEERING INPUTS

INDEX POINT LR1

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0					0.00	0
0	0	0	0	3.18	*12.42*	*0.0000*					*12.42*	*0.0000*
95	0	0	0	0.00	17.00	0.0876	0	0	0	4.84	17.00	0.0876
50	21,899	1,773	1,773	7.50	19.80	0.2557	0	0	0	0.00	19.80	0.2557
20	0	0	0	0.00	22.40	0.4408	21,899	1,717	1,717	8.71	22.40	0.4408
10	79,122	7,757	7,757	14.21	**25.00**	**0.6114**	0	0	0	0.00	**25.00**	**0.6114**
4	124,892	9,142	9,142	15.44	25.01	1.0000	79,122	7,677	7,677	14.66	25.01	1.0000
2	167,074	10,129	10,129	16.23	0	0	124,892	9,031	9,031	15.76	0	0
1	216,499	13,871	13,871	18.93	0	0	167,074	10,012	10,012	16.48	0	0
0.5	273,861	15,724	15,724	22.58	0	0	216,499	13,767	13,767	18.93	0	0
0.2	363,117	16,625	16,625	23.66	0	0	273,861	15,535	15,535	22.59	0	0

INDEX POINT LR2

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
				0.00	0	0				0.00	0.00	0
	0	0	0	3.18	*12.00*	*0.0000*	0	0	0	4.84	*12.00*	*0.0000*
95		0	0	0.00	17.00	0.1287					17.00	0.1287
50	21899	1,771	1,771	7.60	21.50	0.3839	21,899	1,716	1,716	8.77	21.50	0.3839
20		0	0	0.00	24.65	0.5587					24.65	0.5587
10	79122	7,754	7,754	15.14	**27.80**	**0.6903**	79,122	7,669	7,669	15.70	**27.80**	**0.6903**
4	124892	9,143	9,143	16.47	28.81	1.0000	124,892	9,032	9,032	16.94	28.81	1.0000
2	167074	10,130	10,130	17.33			167,074	10,013	10,013	17.76		
1	216499	13,871	13,871	20.25			216,499	13,767	13,767	20.55		
0.5	273861	15,734	15,734	22.96			273,861	15,556	15,556	23.00		
0.2	363117	16,889	16,889	23.78			363,117	16,749	16,749	23.78		

Index point LR3

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
				0.00	0	0				0.00	0	0
	0	0	**0**	3.18	*18.53*	*0.0000*	0	0	0	4.84	*18.53*	*0.0000*
95		0		**0.00**	24.00	0.1472			0		24.00	0.1472
50	21,899	6,391	6,391	8.42	26.90	0.4782	21,899	6,394	6394	9.30	26.90	0.4782
20		0	**0**	**0.00**	28.95	0.8014			0		28.95	0.8014
10	79,122	25,165	25,165	18.21	**31.00**	**0.9999**	79,122	25,000	25000	18.45	**31.00**	**0.9999**
4	124,892	28,844	28,844	19.66	31.01	1.0000	124,892	28,707	28707	19.88	31.01	1.0000
2	167,074	31,599	31,599	20.64			167,074	31,449	31449	20.83		
1	216,499	42,793	42,793	23.93			216,499	42,596	42596	24.06		
0.5	273,861	51,601	51,601	25.56			273,861	51,431	51431	25.61		
0.2	363,117	57,151	57,151	26.78			363,117	57,058	57058	26.79		

Index point LR4

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
				0.00	0	0			0	0.00	0	0
	0	0	0	3.18	*18.60*	*0.0000*	0	0	0	4.84	*18.60*	*0.0000*
95		0		0.00	23.75	0.0538		0	0	0.00	23.75	0.0538
50	21,899	6,390	6,390	10.27	27.50	0.1144	21,899	6,392	6,392	10.82	27.50	0.1144
20		0	0	0.00	31.25	0.1719	0	0	0	0.00	31.25	0.1719
10	79,122	25,167	25,167	21.62	**33.90**	**0.2289**	79,122	25,002	25,002	21.73	**33.90**	**0.2289**
4	124,892	28,849	28,849	23.17	33.91	1.0000	124,892	28,712	28,712	23.27	33.91	1.0000
2	167,074	31,612	31,612	24.21			167,074	31,459	31,459	24.30		
1	216,499	42,800	42,800	27.78			216,499	42,602	42,602	27.83		
0.5	273,861	52,486	52,486	30.03			273,861	52,328	52,328	30.04		
0.2	363,117	63,467	63,467	31.33			363,117	63,389	63,389	31.33		

INDEX POINT LRTB

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
				0.00	0	0				0.00	0	0
	0	0	**0**	3.18	*18.60*	*0.0000*	0	0	0	4.84	*18.60*	*0.0000*
95		0		**0.00**	23.75	0.0029		0	0	0.00	23.75	0.0029
50	21,899	6,390	6,390	10.27	27.50	0.0131	21,899	6,392	6,392	10.82	27.50	0.0131
20		0	**0**	**0.00**	**27.78**	**0.0169**	0	0	0	0.00	**27.78**	**0.0169**
10	79,122	25,167	25,167	21.62	27.79	1.0000	79,122	25,002	25,002	21.73	27.79	1.0000
4	124,892	28,849	28,849	23.17	0.00	0.0000	124,892	28,712	28,712	23.27	0.00	0.0000
2	167,074	31,612	31,612	24.21	0	0	167,074	31,459	31,459	24.30	0	0
1	216,499	42,800	42,800	27.78			216,499	42,602	42,602	27.83		
0.5	273,861	52,486	52,486	30.03			273,861	52,328	52,328	30.04		
0.2	363,117	63,467	63,467	31.33			363,117	63,389	63,389	31.33		

INDEX POINT FL1

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0	0	0			0	0
0	0	0	0	0.00	*9.36*	*0.0000*	0	0	0	4.84	*9.36*	*0.0000*
95	0	0	0	3.18	13.00	0.0610	0	0	0		13.00	0.0610
50	21,899	1,776	1,776	7.33	15.90	0.1282	21,899	1,720	1,720	8.62	15.90	0.1282
20	0	0	0	0.00	18.65	0.1917	0	0	0	0.00	**18.65**	**0.1917**
10	79,122	7,774	7,774	11.75	**21.40**	**0.2418**	79,122	7,690	7,690	12.83	21.40	0.2418
4	124,892	9,142	9,142	12.51	21.41	1.0000	124,892	9,031	9,031	13.51	21.41	1.0000
2	167,074	10,128	10,128	13.09	0	0	167,074	10,012	10,012	14.04	0	0
1	216,499	13,869	13,869	14.65	0	0	216,499	13,766	13,766	15.43	0	0
0.5	273,861	26,687	26,687	20.12	0	0	273,861	25,913	25,913	20.36	0	0
0.2	363,117	32,943	32,943	21.98	0	0	363,117	32,389	32,389	22.05	0	0

Index point FR1

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
	0	0	0	0.00	0	0	0	0	0	0.00	0	0
	0	0	0	0.00	*8.14*	*0.0000*	0	0	0	4.84	*8.14*	*0.0000*
95	0	0	0	3.18	12.96	0.0663	0	0	0		12.96	0.0663
50	21,899	1,776	1,776	7.33	***15.90***	***0.2537***	21,899	1,720	1,720	8.62	***15.90***	***0.2537***
20	0	0	0	0.00	18.84	0.5039	0	0	0	0.00	18.84	0.5039
10	79,122	7,774	7,774	11.75	**21.77**	**0.7183**	79,122	7,690	7,690	12.83	**21.77**	**0.7183**
4	124,892	9,142	9,142	12.51	21.78	1.0000	124,892	9,031	9,031	13.51	21.78	1.0000
2	167,074	10,128	10,128	13.09	0	0	167,074	10,012	10,012	14.04	0	0
1	216,499	13,869	13,869	14.65	0	0	216,499	13,766	13,766	15.43	0	0
0.5	273,861	26,687	26,687	20.12	0	0	273,861	25,913	25,913	20.36	0	0
0.2	363,117	32,943	32,943	21.98	0	0	363,117	32,389	32,389	22.05	0	0

Index point D3

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
	0	0	0	0.00	0	0	0	0	0	0.00	0	0
	0	0	0	0.00	*2.00*	*0.0000*	0	0	0	4.84	*2.00*	*0.0000*
95	0	0	0	3.18	6.00	0.0928	0	0	0	0.00	*6.00*	*0.0928*
50	21,899	2,424	2,424	7.70	8.50	0.2098	21,899	2,257	2,257	8.43	8.50	0.2098
20	0	0	0	0.00	11.00	0.3419	0	0	0	0.00	11.00	0.3419
10	79,122	9,864	9,864	9.30	**13.20**	**0.4593**	79,122	9,774	9,774	10.93	**13.20**	**0.4593**
4	124,892	11,158	11,158	9.70	13.21	1.0000	124,892	11,046	11,046	11.32	13.21	1.0000
2	167,074	12,298	12,298	9.90	0	0	167,074	12,175	12,175	11.54	0	0
1	216,499	15,920	15,920	10.10	0	0	216,499	15,792	15,792	11.76	0	0
0.5	273,861	28,712	28,712	12.12	0	0	273,861	27,834	27,834	13.60	0	0
0.2	363,117	33,013	33,013	13.01	0	0	363,117	31,429	31,429	14.40	0	0

INDEX POINT D-BS

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0	0	0	0	0.00	0	0
0	0	0	0	3.18	*-3.50*	*0.0000*	0	0	0	4.84	*-3.50*	*0.0000*
95	0	0			6.00	0.0743	0	0	0		*6.00*	*0.0743*
50	21,899	2,424	2,424	7.70	10.00	0.2006	21,899	2,257	2,257	8.43	10.00	0.2006
20	0	0	0	0.00	14.00	0.5153	0	0	0	0.00	14.00	0.5153
10	79,122	9,864	9,864	9.29	**18.00**	**0.8532**	79,122	9,774	9,774	10.93	**18.00**	**0.8532**
4	124,892	11,158	11,158	9.70	18.01	1.0000	124,892	11,046	11,046	11.32	18.01	1.0000
2	167,074	12,298	12,298	9.90	0	0	167,074	12,175	12,175	11.54	0	0
1	216,499	15,920	15,920	10.10	0	0	216,499	15,792	15,792	11.76	0	0
0.5	273,861	28,712	28,712	12.12	0	0	273,861	27,834	27,834	13.60	0	0
0.2	363,117	33,013	33,013	13.01	0	0	363,117	31,429	31,429	14.40	0	0

INDEX POINT D4

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0	0	0	0	0.00	0	0
0	0	0	0	3.18	*5.37*	*0.0000*	0	0	0	4.84	*5.37*	*0.0000*
95	0	0	0	0.00	11.89	0.1181	0	0	0	0.00	11.89	0.1181
50	6,901	3,792	3,792	8.35	14.20	0.2809	6,901	3,778	3,778	9.79	14.20	0.2809
20	15,360	9,487	9487	11.29	16.51	0.5062	15,360	9,486	9,486	12.36	16.51	0.5062
10	21,654	9,933	9,933	11.51	**18.82**	**0.8686**	**21,654**	9,933	**9,933**	**12.55**	**18.82**	**0.8686**
4	29,659	12,270	12,270	12.51	18.83	1.0000	29,659	12,270	12,270	13.44	18.83	1.0000
2	35,396	12,752	12,752	12.71			35,396	12,742	12,742	13.69		
1	40,815	15,346	15,346	13.77			40,815	15,346	15,346	14.59		
0.5	45,896	15,736	15,736	14.11			45,896	15,719	15,719	14.96		
0.2	52,080	19,117	19,117	16.30			52,080	19,118	19,118	17.03		

Index point D5

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0	0	0	0	0.00	0	0
0	0	0	0	3.18	*4.10*	*0.0000*	0	0	0	4.84	*4.10*	*0.0000*
95	0	0	0	0.00	7.20	0.0869	0	0	0	0.00	7.20	0.0869
50	6,901	3,784	3,784	8.24	10.00	0.1872	6,901	3,775	3,775	9.71	10.00	0.1872
20	15,360	9,487	9487	10.90	13.20	0.2698	15,360	9,486	9,486	12.04	13.20	0.2698
10	21,654	9,934	9,934	11.10	**17.54**	**0.4023**	21,654	9,944	9,944	12.22	**17.54**	**0.4023**
4	29,659	12,270	12,270	11.97	17.55	1.0000	29,659	12,269	12,269	12.98	17.55	1.0000
2	35,396	12,751	12,751	12.22	0		35,396	12,740	12,740	13.22	0	
1	40,815	15,346	15,346	13.07	0		40,815	15,355	15,355	13.98	0	
0.5	45,896	15,736	15,736	13.41	0		45,896	15,692	15,692	14.35	0	
0.2	52,080	19,117	19,117	15.53	0		52,080	19,118	19,118	16.34	0	

Index point SL1

Annual Chance Exceedance	Without Project											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
			0	0.00	0	0						
	0	0	0	8.64	*25.00*	*0.0000*						
95			0	0.00	30.20	0.0666						
50	6,901	3,696	3,696	21.72	33.19	0.1739						
20	15,360	9,351	9351	26.90	36.17	0.3073						
10	21,654	9,653	9,653	27.16	**39.16**	**0.4424**	Sea level rise does not affect this index point.					
4	29,659	11,963	11,963	28.64	39.26	1.0000						
2	35,396	12,502	12,502	29.01								
1	40,815	14,917	14,917	30.15								
0.5	45,896	15,285	15,285	30.32								
0.2	52,080	18,529	18,529	31.80								

INDEX POINT SL2

Annual Chance Exceedance	Without Project											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
	0	0	0	0.00	0	0						
	0	0	0	23.00	*34.30*	*0.0000*						
95	0	0	0	0.00	37.20	0.0514						
50	6,901	3,740	3,740	31.39	38.80	0.1009						
20	15,360	9,318	9,318	36.61	40.40	0.1533						
10	21,654	9,652	9,652	36.79	**44.56**	**0.3745**	Sea level rise does not affect this index point.					
4	29,659	11,920	11,920	38.12	44.57	1.0000						
2	35,396	12,713	12,713	38.51	0	0						
1	40,815	14,813	14,813	39.64	0	0						
0.5	45,896	15,204	15,204	39.83	0	0						
0.2	52,080	18,436	18,436	42.23	0	0						

INDEX POINT CR2

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0						
0	0	0	0	6.60	*23.80*	*0.0000*						
95	0	0	0	0.00	25.30	0.0892						
50	6,901	3,848	3,848	19.13	26.90	0.1783						
20	15,360	9,496	9,496	23.35	28.20	0.3036						
10	21,654	9,861	9,861	23.58	**29.66**	**0.4846**	Sea level rise does not affect this index point.					
4	29,659	12,282	12,282	24.81	29.76	1.0000						
2	35,396	12,846	12,846	25.11	0	0						
1	40,815	15,359	15,359	26.29	0	0						
0.5	45,896	15,750	15,750	26.46	0	0						
0.2	52,080	19,126	19,126	27.98	0	0						

INDEX POINT CL2

Annual Chance Exceedance	WITHOUT PROJECT											
	2010						2070					
	Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve		Unregulated-Regulated Transform		Discharge-Stage Rating		Fragility Curve	
	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure	Unregulated Flow	Regulated Flow	Regulated Discharge	Regulated Stage	Stage	*P* of Failure
0	0	0	0	0.00	0	0						
0	0	0	0	6.60	*21.00*	*0.0000*						
95	0	0	0	0.00	25.50	0.0845						
50	6,901	3,848	3,848	19.13	27.46	0.1719						
20	15,360	9,496	9,496	23.35	29.40	0.2527						
10	21,654	9,861	9,861	23.58	**31.43**	**0.3790**	Sea level rise does not affect this index point.					
4	29,659	12,282	12,282	24.81	31.53	1.0000						
2	35,396	12,846	12,846	25.11								
1	40,815	15,359	15,359	26.29								
0.5	45,896	15,750	15,750	26.46								
0.2	52,080	19,126	19,126	27.98								

ATTACHMENT 6: PROJECT PERFORMANCE STATISTICS

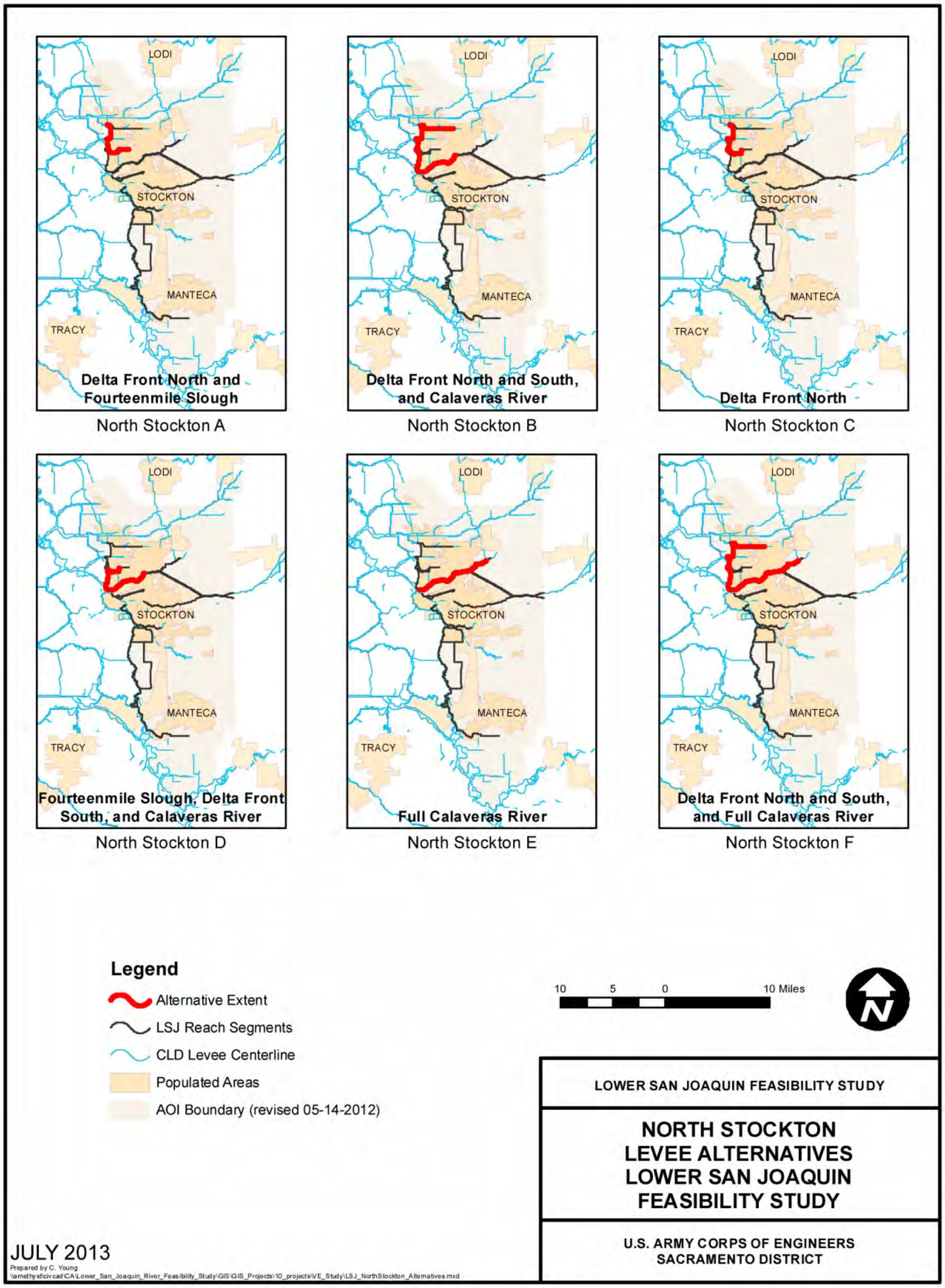
PROJECT PERFORMANCE—EXISTING CONDITION

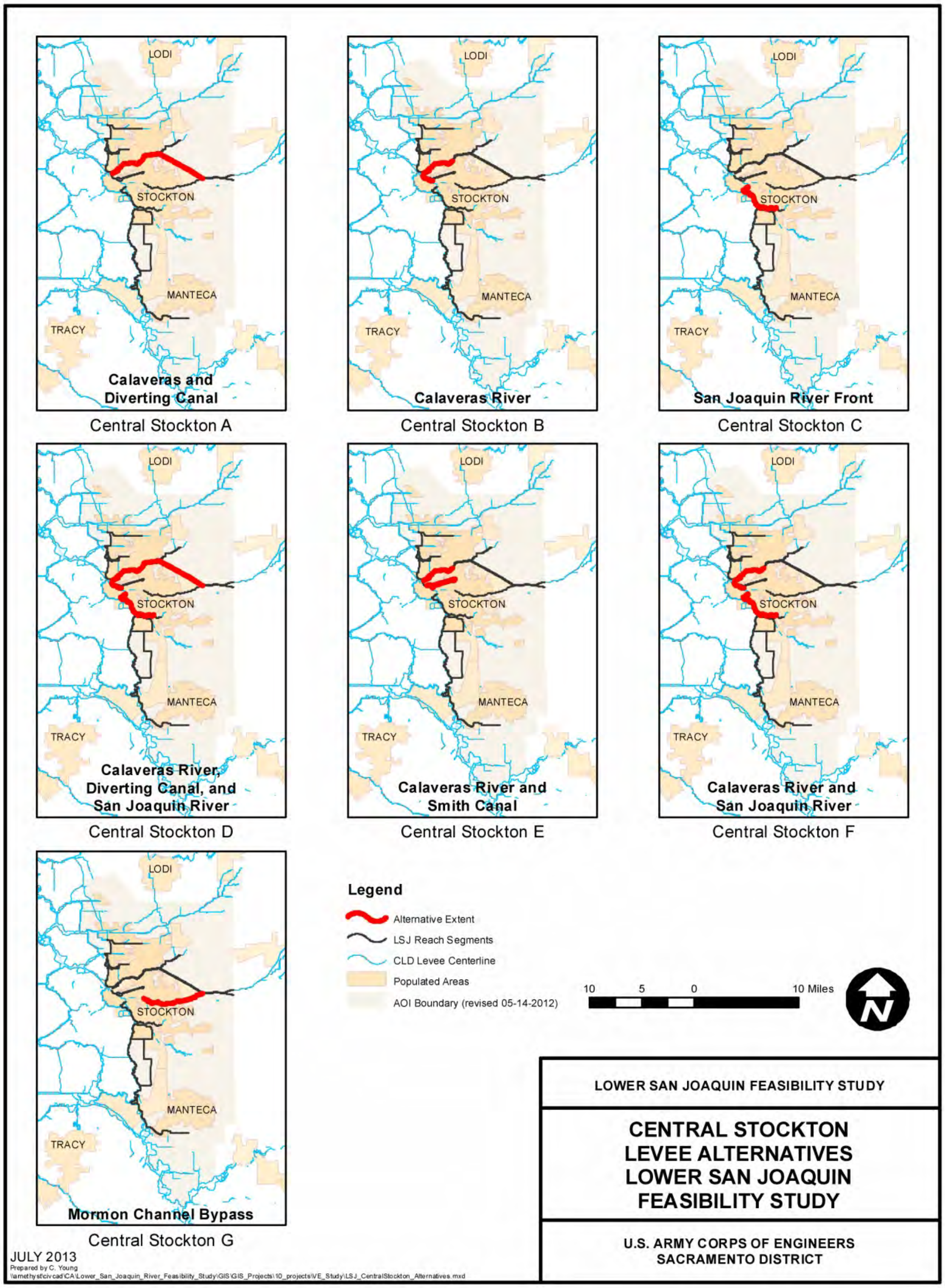
Breach Location	Plan	Annual Exceedence Probability	Long-Term Risk			Assurance by Event					
			10 years	30 years	50 years	0.1	0.04	0.02	0.01	0.004	0.002
CR2	WO	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-7a	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-8a	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9998	0.9984	0.9912	0.9828
	LS-9a	0.0051	0.0497	0.1419	0.2251	0.9916	0.9619	0.9320	0.8921	0.8349	0.7965
	LS-7b	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-8b	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9998	0.9984	0.9912	0.9828
	LS-9b	0.0051	0.0497	0.1419	0.2251	0.9916	0.9619	0.9320	0.8921	0.8349	0.7965
CL2	WO	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8292
	LS-7a	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8292
	LS-8a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9a	0.0145	0.1361	0.3552	0.5187	0.9577	0.9533	0.9374	0.9110	0.8753	0.8536
	LS-7b	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8262
	LS-8b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9b	0.0145	0.1361	0.3552	0.5187	0.9577	0.9533	0.9374	0.9110	0.8753	0.8536
D3	WO	0.1519	0.8074	0.9929	0.9997	0.7477	0.7230	0.7021	0.6330	0.4695	0.3859
	LS-7a	0.0003	0.0025	0.0076	0.0126	0.9999	0.9998	0.9989	0.9896	0.9522	0.9226
	LS-8a	0.0003	0.0025	0.0076	0.0126	0.9999	0.9998	0.9989	0.9896	0.9522	0.9226
	LS-9a	0.0003	0.0025	0.0076	0.0126	0.9999	0.9998	0.9989	0.9896	0.9522	0.9226
	LS-7b	0.0000	0.0003	0.0009	0.0014	0.9999	0.9998	0.9996	0.9993	0.9989	0.9987
	LS-8b	0.0000	0.0003	0.0009	0.0014	0.9999	0.9998	0.9996	0.9993	0.9989	0.9987
	LS-9b	0.0000	0.0003	0.0009	0.0014	0.9999	0.9998	0.9996	0.9993	0.9989	0.9987
D4	WO	0.0646	0.4872	0.8652	0.9645	0.8776	0.8283	0.7876	0.7291	0.6296	0.5608
	LS-7a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9998	0.9980	0.9895	0.9799
	LS-8a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9998	0.9980	0.9895	0.9799
	LS-9a	0.0000	0.0003	0.0008	0.0014	0.9999	0.9999	0.9999	0.9995	0.9975	0.9950
	LS-7b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9998	0.9980	0.9895	0.9799
	LS-8b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9998	0.9980	0.9895	0.9799
	LS-9b	0.0000	0.0003	0.0008	0.0014	0.9999	0.9999	0.9999	0.9995	0.9975	0.9950
D5	WO	0.1197	0.7206	0.9782	0.9983	0.7806	0.7593	0.7426	0.7206	0.6827	0.6545
	LS-7a	0.0001	0.0014	0.0041	0.0068	0.9999	0.9999	0.9994	0.9951	0.9769	0.9564
	LS-8a	0.0001	0.0014	0.0041	0.0068	0.9999	0.9999	0.9994	0.9951	0.9769	0.9564
	LS-9a	0.0000	0.0005	0.0016	0.0026	0.9999	0.9999	0.9998	0.9986	0.9929	0.9864
	LS-7b	0.0001	0.0014	0.0041	0.0068	0.9999	0.9999	0.9994	0.9951	0.9769	0.9564
	LS-8b	0.0001	0.0014	0.0041	0.0068	0.9999	0.9999	0.9994	0.9951	0.9769	0.9564
	LS-9b	0.0000	0.0005	0.0016	0.0026	0.9999	0.9999	0.9998	0.9986	0.9929	0.9864
D-BS	WO	0.1521	0.8079	0.9929	0.9997	0.8005	0.7712	0.7522	0.7085	0.6240	0.5848
	LS-7a	0.0000	0.0004	0.0013	0.0021	0.9999	0.9999	0.9999	0.9999	0.9997	0.9996
	LS-8a	0.0000	0.0004	0.0013	0.0021	0.9999	0.9999	0.9999	0.9999	0.9997	0.9996
	LS-9a	0.0000	0.0004	0.0013	0.0021	0.9999	0.9999	0.9999	0.9999	0.9997	0.9996
	LS-7b	0.0000	0.0004	0.0012	0.0019	0.9999	0.9999	0.9999	0.9998	0.9997	0.9996
	LS-8b	0.0000	0.0004	0.0012	0.0019	0.9999	0.9999	0.9999	0.9998	0.9997	0.9996
	LS-9b	0.0000	0.0004	0.0012	0.0019	0.9999	0.9999	0.9999	0.9998	0.9997	0.9996
FL1	WO	0.0132	0.1245	0.3290	0.4857	0.9629	0.9460	0.9208	0.8269	0.5585	0.3857
	LS-7a	0.0132	0.1245	0.3290	0.4857	0.9629	0.9460	0.9208	0.8269	0.5585	0.3857
	LS-8a	0.0132	0.1245	0.3290	0.4857	0.9629	0.9460	0.9208	0.8269	0.5585	0.3857
	LS-9a	0.0132	0.1245	0.3290	0.4857	0.9629	0.9460	0.9208	0.8269	0.5585	0.3857
	LS-7b	0.0000	0.0004	0.0013	0.0022	0.9999	0.9999	0.9999	0.9998	0.9996	0.9993
	LS-8b	0.0000	0.0004	0.0013	0.0022	0.9999	0.9999	0.9999	0.9998	0.9996	0.9993
	LS-9b	0.0000	0.0004	0.0013	0.0022	0.9999	0.9999	0.9999	0.9998	0.9996	0.9993
FR1	WO	0.0270	0.2393	0.5596	0.7451	0.9490	0.9121	0.8065	0.4864	0.0984	0.0158
	LS-7a	0.0073	0.0705	0.1969	0.3062	0.9999	0.9999	0.9766	0.7718	0.2721	0.0785
	LS-8a	0.0073	0.0705	0.1969	0.3062	0.9999	0.9999	0.9766	0.7718	0.2721	0.0785
	LS-9a	0.0073	0.0705	0.1969	0.3062	0.9999	0.9999	0.9766	0.7718	0.2721	0.0785
	LS-7b	0.0070	0.0679	0.1901	0.2963	0.9997	0.9935	0.9328	0.7353	0.4498	0.3465
	LS-8b	0.0070	0.0679	0.1901	0.2963	0.9997	0.9935	0.9328	0.7353	0.4498	0.3465
	LS-9b	0.0070	0.0679	0.1901	0.2963	0.9997	0.9935	0.9328	0.7353	0.4498	0.3465
LR1	WO	0.0126	0.1188	0.3158	0.4688	0.9610	0.9400	0.8830	0.7439	0.5438	0.4620
	LS-7a	0.0126	0.1188	0.3158	0.4688	0.9610	0.9400	0.8830	0.7439	0.5438	0.4620
	LS-8a	0.0126	0.1188	0.3158	0.4688	0.9610	0.9400	0.8830	0.7439	0.5438	0.4620
	LS-9a	0.0126	0.1188	0.3158	0.4688	0.9610	0.9400	0.8830	0.7439	0.5438	0.4620
	LS-7b	0.0000	0.0003	0.0010	0.0017	0.9999	0.9999	0.9999	0.9987	0.9944	0.9917
	LS-8b	0.0000	0.0003	0.0010	0.0017	0.9999	0.9999	0.9999	0.9987	0.9944	0.9917
	LS-9b	0.0000	0.0003	0.0010	0.0017	0.9999	0.9999	0.9999	0.9987	0.9944	0.9917
LR2	WO	0.0211	0.1923	0.4731	0.6563	0.9289	0.8683	0.7922	0.6831	0.5579	0.5161
	LS-7a	0.0211	0.1923	0.4731	0.6563	0.9289	0.8683	0.7922	0.6831	0.5579	0.5161
	LS-8a	0.0211	0.1923	0.4731	0.6563	0.9289	0.8683	0.7922	0.6831	0.5579	0.5161
	LS-9a	0.0211	0.1923	0.4731	0.6563	0.9289	0.8683	0.7922	0.6831	0.5579	0.5161
	LS-7b	0.0000	0.0001	0.0004	0.0006	0.9999	0.9999	0.9999	0.9997	0.9987	0.9978
	LS-8b	0.0000	0.0001	0.0004	0.0006	0.9999	0.9999	0.9999	0.9997	0.9987	0.9978
	LS-9b	0.0000	0.0001	0.0004	0.0006	0.9999	0.9999	0.9999	0.9997	0.9987	0.9978
LR3	WO	0.0095	0.0913	0.2496	0.3803	0.9761	0.9394	0.8998	0.7938	0.6365	0.5650
	LS-7a	0.0095	0.0913	0.2496	0.3803	0.9761	0.9394	0.8998	0.7938	0.6365	0.5650
	LS-8a	0.0095	0.0913	0.2496	0.3803	0.9761	0.9394	0.8998	0.7938	0.6365	0.5650
	LS-9a	0.0095	0.0913	0.2496	0.3803	0.9761	0.9394	0.8998	0.7938	0.6365	0.5650
	LS-7b	0.0000	0.0005	0.0016	0.0027	0.9999	0.9999	0.9999	0.9982	0.9881	0.9781
	LS-8b	0.0000	0.0005	0.0016	0.0027	0.9999	0.9999	0.9999	0.9982	0.9881	0.9781
	LS-9b	0.0000	0.0005	0.0016	0.0027	0.9999	0.9999	0.9999	0.9982	0.9881	0.9781
LR4	WO	0.0073	0.0706	0.1971	0.3064	0.9731	0.9525	0.9241	0.8826	0.8342	0.8095
	LS-7a	0.0073	0.0706	0.1971	0.3064	0.9731	0.9525	0.9241	0.8826	0.8342	0.8095
	LS-8a	0.0073	0.0706	0.1971	0.3064	0.9731	0.9525	0.9241	0.8826	0.8342	0.8095
	LS-9a	0.0073	0.0706	0.1971	0.3064	0.9731	0.9525	0.9241	0.8826	0.8342	0.8095
	LS-7b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
	LS-8b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
	LS-9b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
LRTB	WO	0.0117	0.0110	0.2973	0.4446	0.9984	0.9918	0.8749	0.5090	0.1271	0.0384
	LS-7a	0.0117	0.0110	0.2973	0.4446	0.9984	0.9918	0.8749	0.5090	0.1271	0.0384
	LS-8a	0.0117	0.0110	0.2973	0.4446	0.9984	0.9918	0.8749	0.5090	0.1271	0.0384
	LS-9a	0.0117	0.0110	0.2973	0.4446	0.9984	0.9918	0.8749	0.5090	0.1271	0.0384
	LS-7b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
	LS-8b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
	LS-9b	0.0003	0.0034	0.0101	0.0168	0.9999	0.9999	0.9995	0.9888	0.9219	0.8544
SL1	WO	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-7a	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-8a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9a	0.0089	0.0859	0.2363	0.3619	0.9670	0.9661	0.9606	0.9469	0.9220	0.9057
	LS-7b	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-8b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9b	0.0089	0.0859	0.2363	0.3619	0.9670	0.9661	0.9606	0.9469	0.9220	0.9057
SL2	WO	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-7a	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-8a	0.0000	0.0002	0.0006	0.0010	0.9999	0.9999	0.9999	0.9998	0.9989	0.9976
	LS-9a	0.0109	0.1036	0.2797	0.4211	0.9700	0.9432	0.9194	0.8897	0.8396	0.8029
	LS-7b	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-8b	0.0000	0.0002	0.0006	0.0010	0.9999	0.9999	0.9999	0.9998	0.9989	0.9976
	LS-9b	0.0109	0.1036	0.2797	0.4211	0.9700	0.9432	0.9194	0.8897	0.8396	0.8029

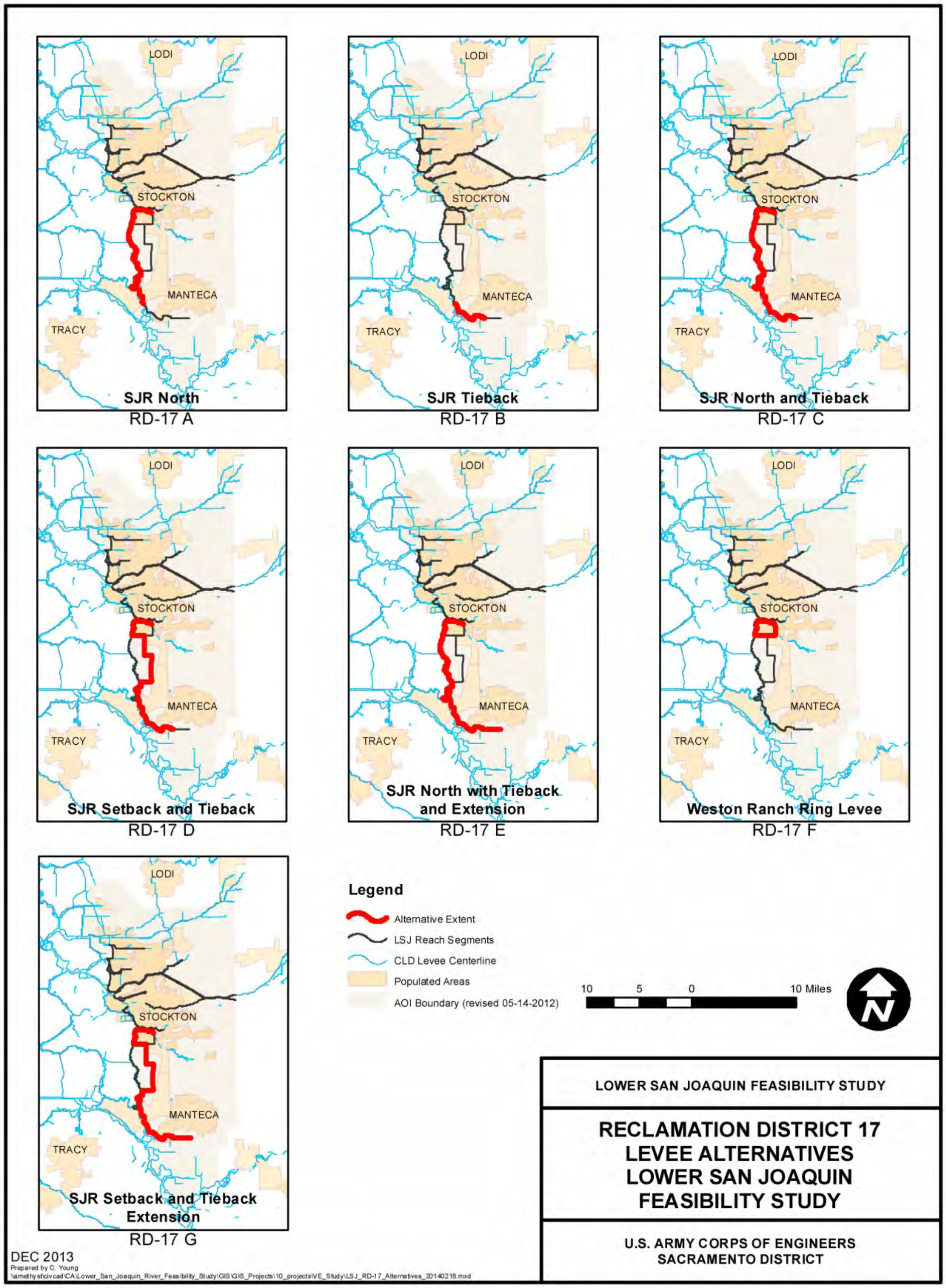
Project Performance—Future Condition

Breach Location	Plan	Annual Exceedence Probability	Long-Term Risk			Assurance by Event					
			10 years	30 years	50 years	0.1	0.04	0.02	0.01	0.004	0.002
CR2	WO	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-7a	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-8a	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9998	0.9984	0.9912	0.9828
	LS-9a	0.0051	0.0497	0.1419	0.2251	0.9916	0.9619	0.9320	0.8921	0.8349	0.7965
	LS-7b	0.0094	0.0903	0.2471	0.3769	0.9752	0.9356	0.9011	0.8563	0.7895	0.7440
	LS-8b	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9998	0.9984	0.9912	0.9828
	LS-9b	0.0051	0.0497	0.1419	0.2251	0.9916	0.9619	0.9320	0.8921	0.8349	0.7965
CL2	WO	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8292
	LS-7a	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8292
	LS-8a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9a	0.0145	0.1361	0.3552	0.5187	0.9577	0.9533	0.9374	0.9110	0.8753	0.8536
	LS-7b	0.0168	0.1562	0.3991	0.5721	0.9566	0.9410	0.9174	0.8881	0.8515	0.8262
	LS-8b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9b	0.0145	0.1361	0.3552	0.5187	0.9577	0.9533	0.9374	0.9110	0.8753	0.8536
D3	WO	0.2091	0.9043	0.9991	0.9999	0.6418	0.5907	0.5516	0.4483	0.2502	0.1665
	LS-7a	0.0021	0.0207	0.0608	0.0992	0.9968	0.9919	0.9830	0.9331	0.7862	0.6974
	LS-8a	0.0021	0.0207	0.0608	0.0992	0.9968	0.9919	0.9830	0.9331	0.7862	0.6974
	LS-9a	0.0021	0.0207	0.0608	0.0992	0.9968	0.9919	0.9830	0.9331	0.7862	0.6974
	LS-7b	0.0010	0.0099	0.0294	0.0485	0.9967	0.9917	0.9873	0.9824	0.9767	0.9742
	LS-8b	0.0010	0.0099	0.0294	0.0485	0.9967	0.9917	0.9873	0.9824	0.9767	0.9742
	LS-9b	0.0010	0.0099	0.0294	0.0485	0.9967	0.9917	0.9873	0.9824	0.9767	0.9742
D4	WO	0.0962	0.6361	0.9518	0.9936	0.8140	0.7601	0.7164	0.6577	0.5668	0.5067
	LS-7a	0.0001	0.0013	0.0040	0.0067	0.9999	0.9999	0.9992	0.9952	0.9801	0.9642
	LS-8a	0.0001	0.0013	0.0040	0.0067	0.9999	0.9999	0.9992	0.9952	0.9801	0.9642
	LS-9a	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9997	0.9983	0.9924	0.9861
	LS-7b	0.0001	0.0013	0.0040	0.0067	0.9999	0.9999	0.9992	0.9952	0.9801	0.9642
	LS-8b	0.0001	0.0013	0.0040	0.0067	0.9999	0.9999	0.9992	0.9952	0.9801	0.9642
	LS-9b	0.0001	0.0006	0.0017	0.0029	0.9999	0.9999	0.9997	0.9983	0.9924	0.9861
D5	WO	0.1582	0.8214	0.9943	0.9998	0.7473	0.7262	0.7097	0.6851	0.6347	0.5926
	LS-7a	0.0005	0.0047	0.0139	0.0231	0.9998	0.9992	0.9965	0.9831	0.9316	0.8794
	LS-8a	0.0005	0.0047	0.0139	0.0231	0.9998	0.9992	0.9965	0.9831	0.9316	0.8794
	LS-9a	0.0002	0.0019	0.0058	0.0096	0.9999	0.9997	0.9987	0.9932	0.9717	0.9482
	LS-7b	0.0005	0.0047	0.0139	0.0231	0.9998	0.9992	0.9965	0.9831	0.9316	0.8794
	LS-8b	0.0005	0.0047	0.0139	0.0231	0.9998	0.9992	0.9965	0.9831	0.9316	0.8794
	LS-9b	0.0002	0.0019	0.0058	0.0096	0.9999	0.9997	0.9987	0.9932	0.9717	0.9482
D-BS	WO	0.1890	0.8769	0.9981	0.9999	0.7013	0.6723	0.6544	0.6076	0.5112	0.4655
	LS-7a	0.0000	0.0002	0.0007	0.0012	0.9999	0.9999	0.9999	0.9993	0.9964	0.9938
	LS-8a	0.0000	0.0002	0.0007	0.0012	0.9999	0.9999	0.9999	0.9993	0.9964	0.9938
	LS-9a	0.0000	0.0002	0.0007	0.0012	0.9999	0.9999	0.9999	0.9993	0.9964	0.9938
	LS-7b	0.0000	0.0004	0.0012	0.0020	0.9999	0.9999	0.9998	0.9997	0.9996	0.9996
	LS-8b	0.0000	0.0004	0.0012	0.0020	0.9999	0.9999	0.9998	0.9997	0.9996	0.9996
	LS-9b	0.0000	0.0004	0.0012	0.0020	0.9999	0.9999	0.9998	0.9997	0.9996	0.9996
FL1	WO	0.0202	0.1849	0.4586	0.6403	0.9443	0.9244	0.9005	0.8055	0.5337	0.3647
	LS-7a	0.0202	0.1849	0.4586	0.6403	0.9443	0.9244	0.9005	0.8055	0.5337	0.3647
	LS-8a	0.0202	0.1849	0.4586	0.6403	0.9443	0.9244	0.9005	0.8055	0.5337	0.3647
	LS-9a	0.0202	0.1849	0.4586	0.6403	0.9443	0.9244	0.9005	0.8055	0.5337	0.3647
	LS-7b	0.0000	0.0001	0.0003	0.0010	0.9999	0.9999	0.9999	0.9997	0.9991	0.9987
	LS-8b	0.0000	0.0001	0.0003	0.0010	0.9999	0.9999	0.9999	0.9997	0.9991	0.9987
	LS-9b	0.0000	0.0001	0.0003	0.0010	0.9999	0.9999	0.9999	0.9997	0.9991	0.9987
FR1	WO	0.0415	0.3458	0.7200	0.8801	0.9098	0.8425	0.7033	0.3926	0.0736	0.0111
	LS-7a	0.0078	0.0753	0.2093	0.3238	0.9999	0.9994	0.9679	0.7401	0.2432	0.0673
	LS-8a	0.0078	0.0753	0.2093	0.3238	0.9999	0.9994	0.9679	0.7401	0.2432	0.0673
	LS-9a	0.0078	0.0753	0.2093	0.3238	0.9999	0.9994	0.9679	0.7401	0.2432	0.0673
	LS-7b	0.0120	0.1137	0.3037	0.4530	0.9938	0.9549	0.8333	0.5886	0.3165	0.2332
	LS-8b	0.0120	0.1137	0.3037	0.4530	0.9938	0.9549	0.8333	0.5886	0.3165	0.2332
	LS-9b	0.0120	0.1137	0.3037	0.4530	0.9938	0.9549	0.8333	0.5886	0.3165	0.2332
LR1	WO	0.0141	0.1326	0.3475	0.5091	0.9567	0.9334	0.8764	0.7412	0.5426	0.4616
	LS-7a	0.0141	0.1326	0.3475	0.5091	0.9567	0.9334	0.8764	0.7412	0.5426	0.4616
	LS-8a	0.0141	0.1326	0.3475	0.5091	0.9567	0.9334	0.8764	0.7412	0.5426	0.4616
	LS-9a	0.0141	0.1326	0.3475	0.5091	0.9567	0.9334	0.8764	0.7412	0.5426	0.4616
	LS-7b	0.0013	0.0128	0.0380	0.0626	0.9999	0.9999	0.9958	0.9554	0.8571	0.8231
	LS-8b	0.0013	0.0128	0.0380	0.0626	0.9999	0.9999	0.9958	0.9554	0.8571	0.8231
	LS-9b	0.0013	0.0128	0.0380	0.0626	0.9999	0.9999	0.9958	0.9554	0.8571	0.8231
LR2	WO	0.0257	0.2295	0.5426	0.7285	0.9153	0.8415	0.7718	0.6711	0.5541	0.5153
	LS-7a	0.0257	0.2295	0.5426	0.7285	0.9153	0.8415	0.7718	0.6711	0.5541	0.5153
	LS-8a	0.0257	0.2295	0.5426	0.7285	0.9153	0.8415	0.7718	0.6711	0.5541	0.5153
	LS-9a	0.0257	0.2295	0.5426	0.7285	0.9153	0.8415	0.7718	0.6711	0.5541	0.5153
	LS-7b	0.0000	0.0005	0.0014	0.0024	0.9999	0.9999	0.9999	0.9996	0.9992	0.9991
	LS-8b	0.0000	0.0005	0.0014	0.0024	0.9999	0.9999	0.9999	0.9996	0.9992	0.9991
	LS-9b	0.0000	0.0005	0.0014	0.0024	0.9999	0.9999	0.9999	0.9996	0.9992	0.9991
LR3	WO	0.0101	0.0968	0.2632	0.3990	0.9715	0.9362	0.8962	0.7875	0.6337	0.5652
	LS-7a	0.0101	0.0968	0.2632	0.3990	0.9715	0.9362	0.8962	0.7875	0.6337	0.5652
	LS-8a	0.0101	0.0968	0.2632	0.3990	0.9715	0.9362	0.8962	0.7875	0.6337	0.5652
	LS-9a	0.0101	0.0968	0.2632	0.3990	0.9715	0.9362	0.8962	0.7875	0.6337	0.5652
	LS-7b	0.0000	0.0002	0.0005	0.0008	0.9999	0.9999	0.9999	0.9995	0.9981	0.9976
	LS-8b	0.0000	0.0002	0.0005	0.0008	0.9999	0.9999	0.9999	0.9995	0.9981	0.9976
	LS-9b	0.0000	0.0002	0.0005	0.0008	0.9999	0.9999	0.9999	0.9995	0.9981	0.9976
LR4	WO	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-7a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-8a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-9a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-7b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
	LS-8b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
	LS-9b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
LRTB	WO	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-7a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-8a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-9a	0.0075	0.0726	0.2023	0.3139	0.9725	0.9509	0.9228	0.8819	0.8336	0.8093
	LS-7b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
	LS-8b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
	LS-9b	0.0000	0.0005	0.0015	0.0025	0.9999	0.9999	0.9998	0.9976	0.9926	0.9909
SL1	WO	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-7a	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-8a	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9a	0.0089	0.0859	0.2363	0.3619	0.9670	0.9661	0.9606	0.9469	0.9220	0.9057
	LS-7b	0.0105	0.1003	0.2717	0.4104	0.9666	0.9633	0.9509	0.9306	0.9044	0.8900
	LS-8b	0.0001	0.0007	0.0020	0.0034	0.9999	0.9999	0.9999	0.9999	0.9998	0.9998
	LS-9b	0.0089	0.0859	0.2363	0.3619	0.9670	0.9661	0.9606	0.9469	0.9220	0.9057
SL2	WO	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-7a	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-8a	0.0000	0.0002	0.0006	0.0010	0.9999	0.9999	0.9999	0.9998	0.9989	0.9976
	LS-9a	0.0109	0.1036	0.2797	0.4211	0.9700	0.9432	0.9194	0.8897	0.8396	0.8029
	LS-7b	0.0153	0.1428	0.3701	0.5372	0.9543	0.9220	0.8951	0.8595	0.8058	0.7724
	LS-8b	0.0000	0.0002	0.0006	0.0010	0.9999	0.9999	0.9999	0.9998	0.9989	0.9976
	LS-9b	0.0109	0.1036	0.2797	0.4211	0.9700	0.9432	0.9194	0.8897	0.8396	0.8029

ATTACHMENT 7: INITIAL ARRAY OF ALTERNATIVES MAPS

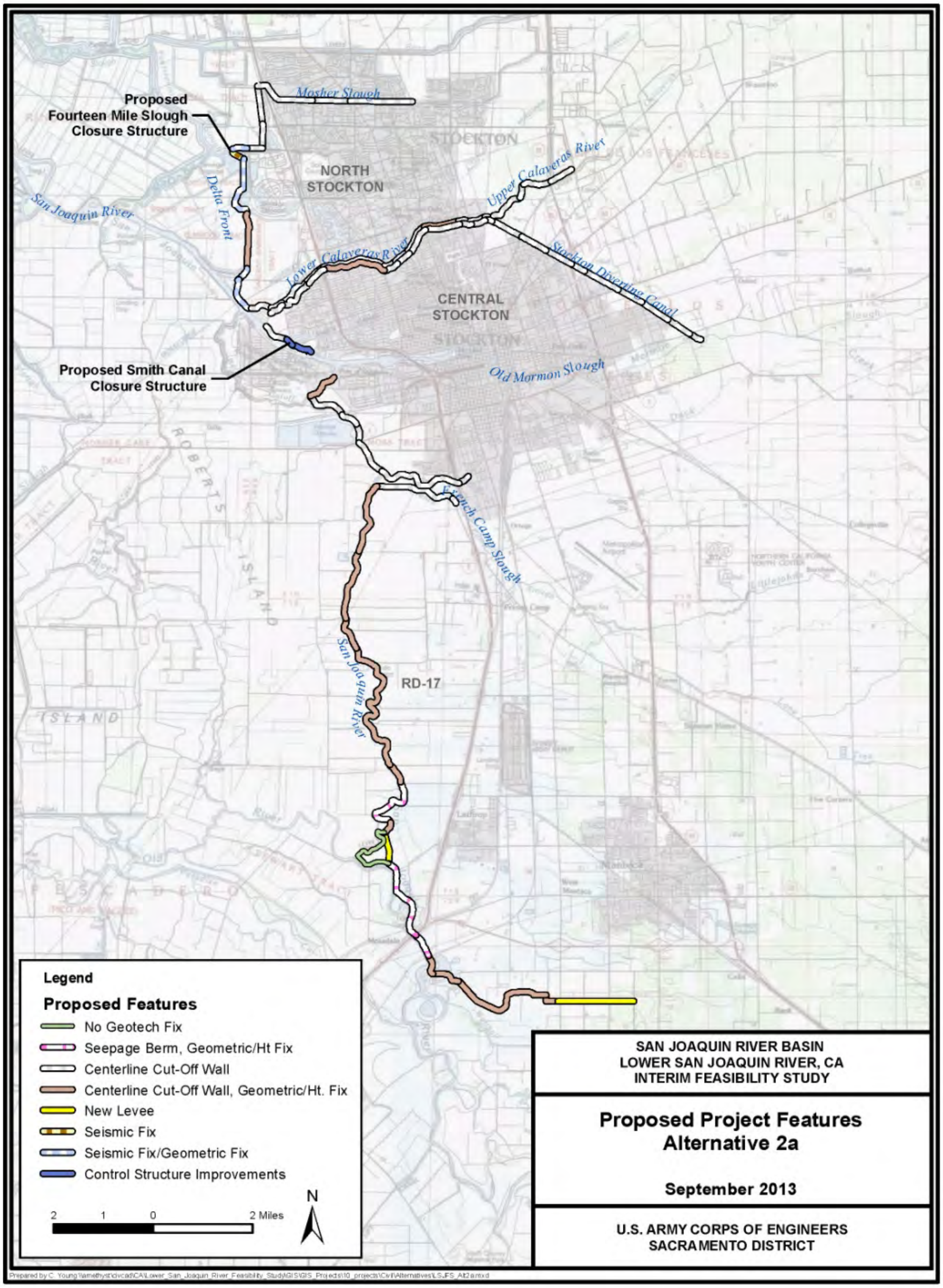

LODI
STOCKTON
MANTECA
TRACY
Delta Front North and Fourteenmile Slough
North Stockton A
Delta Front North and South, and Calaveras River
North Stockton B
Delta Front North
North Stockton C
Fourteenmile Slough, Delta Front South, and Calaveras River
North Stockton D
Full Calaveras River
North Stockton E
Delta Front North and South, and Full Calaveras River
North Stockton F
Legend
Alternative Extent
LSJ Reach Segments
CLD Levee Centerline
Populated Areas
AOI Boundary (revised 05-14-2012)
10 5 0 10 Miles
N
LOWER SAN JOAQUIN FEASIBILITY STUDY
NORTH STOCKTON
LEVEE ALTERNATIVES
LOWER SAN JOAQUIN
FEASIBILITY STUDY
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
JULY 2013
Prepared by C. Young


LODI
STOCKTON
MANTECA
TRACY
Calaveras and Diverting Canal
Central Stockton A
Calaveras River
Central Stockton B
San Joaquin River Front
Central Stockton C
Calaveras River, Diverting Canal, and San Joaquin River
Central Stockton D
Calaveras River and Smith Canal
Central Stockton E
Calaveras River and San Joaquin River
Central Stockton F
Mormon Channel Bypass
Central Stockton G
Legend
Alternative Extent
LSJ Reach Segments
CLD Levee Centerline
Populated Areas
AOI Boundary (revised 05-14-2012)
10 5 0 10 Miles
N
LOWER SAN JOAQUIN FEASIBILITY STUDY
CENTRAL STOCKTON LEVEE ALTERNATIVES LOWER SAN JOAQUIN FEASIBILITY STUDY
U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT
JULY 2013
Prepared by C. Young

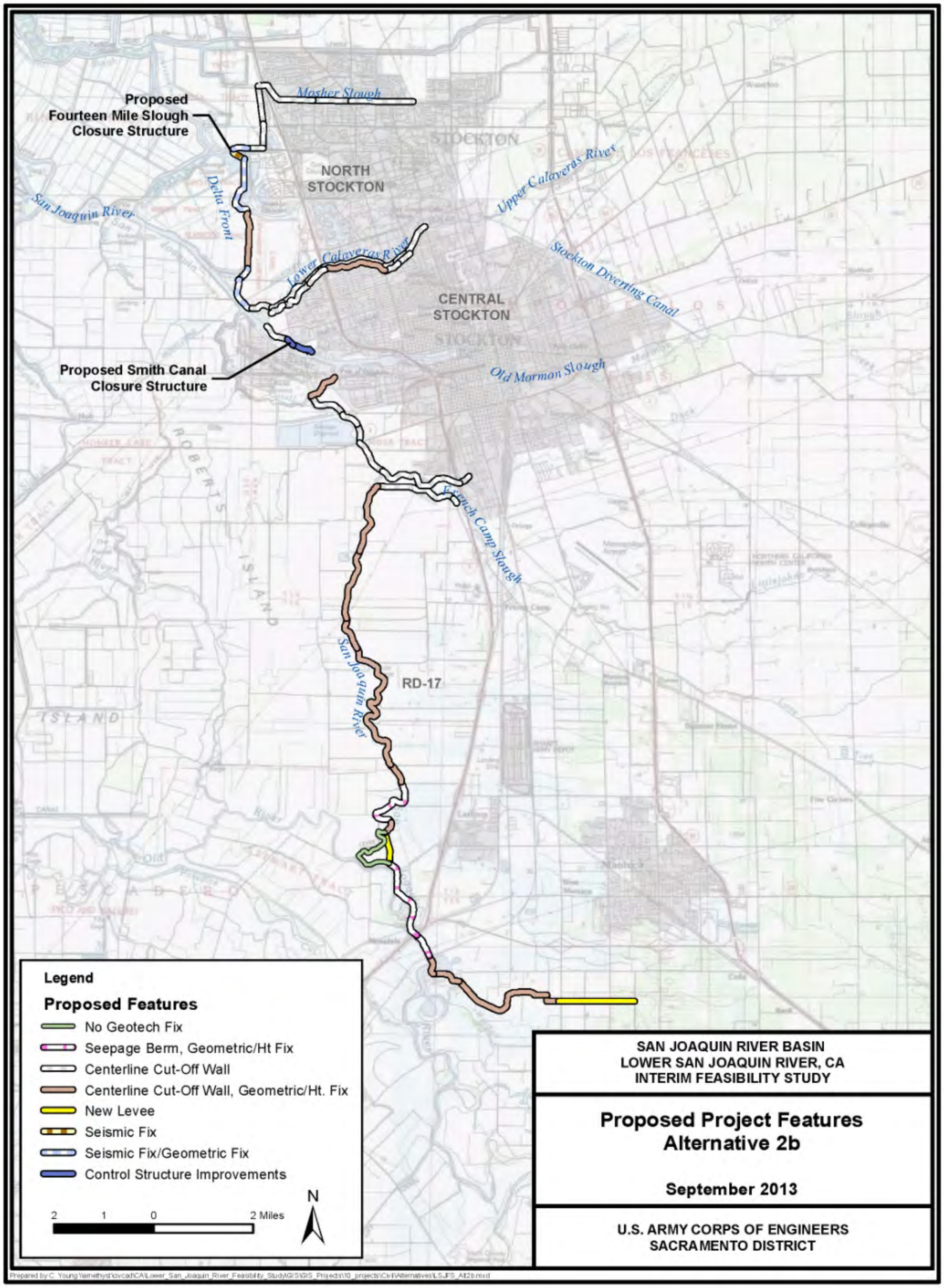

LODI
STOCKTON
MANTECA
TRACY
SJR North
RD-17 A
SJR Tieback
RD-17 B
SJR North and Tieback
RD-17 C
SJR Setback and Tieback
RD-17 D
SJR North with Tieback and Extension
RD-17 E
Weston Ranch Ring Levee
RD-17 F
SJR Setback and Tieback Extension
RD-17 G
Legend
Alternative Extent
LSJ Reach Segments
CLD Levee Centerline
Populated Areas
AOI Boundary (revised 05-14-2012)
10 5 0 10 Miles
N
LOWER SAN JOAQUIN FEASIBILITY STUDY
RECLAMATION DISTRICT 17
LEVEE ALTERNATIVES
LOWER SAN JOAQUIN
FEASIBILITY STUDY
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
DEC 2013
Prepared by C. Young

ATTACHMENT 8: FOCUSED ARRAY OF ALTERNATIVES MAPS

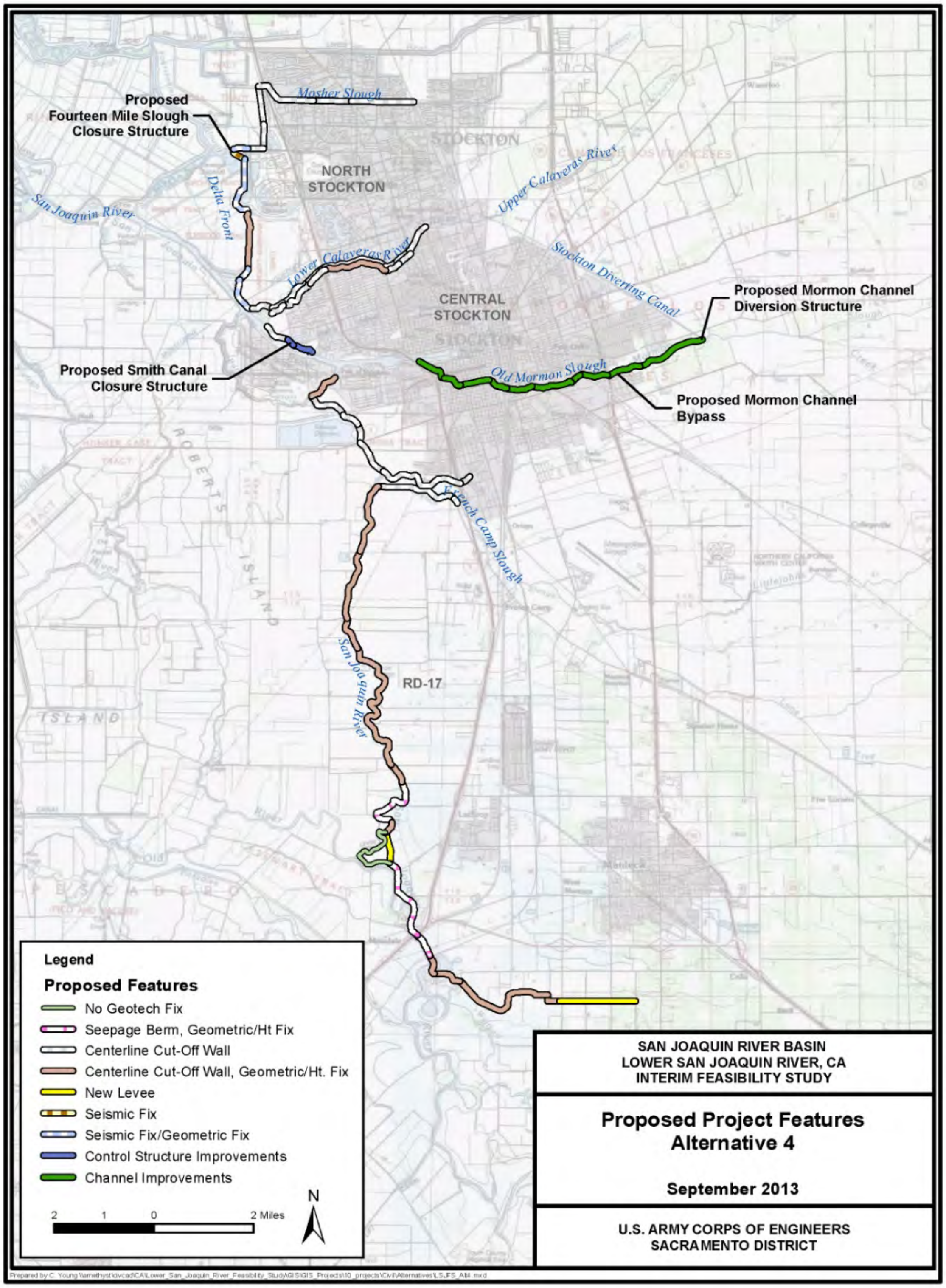
ALTERNATIVE 2A



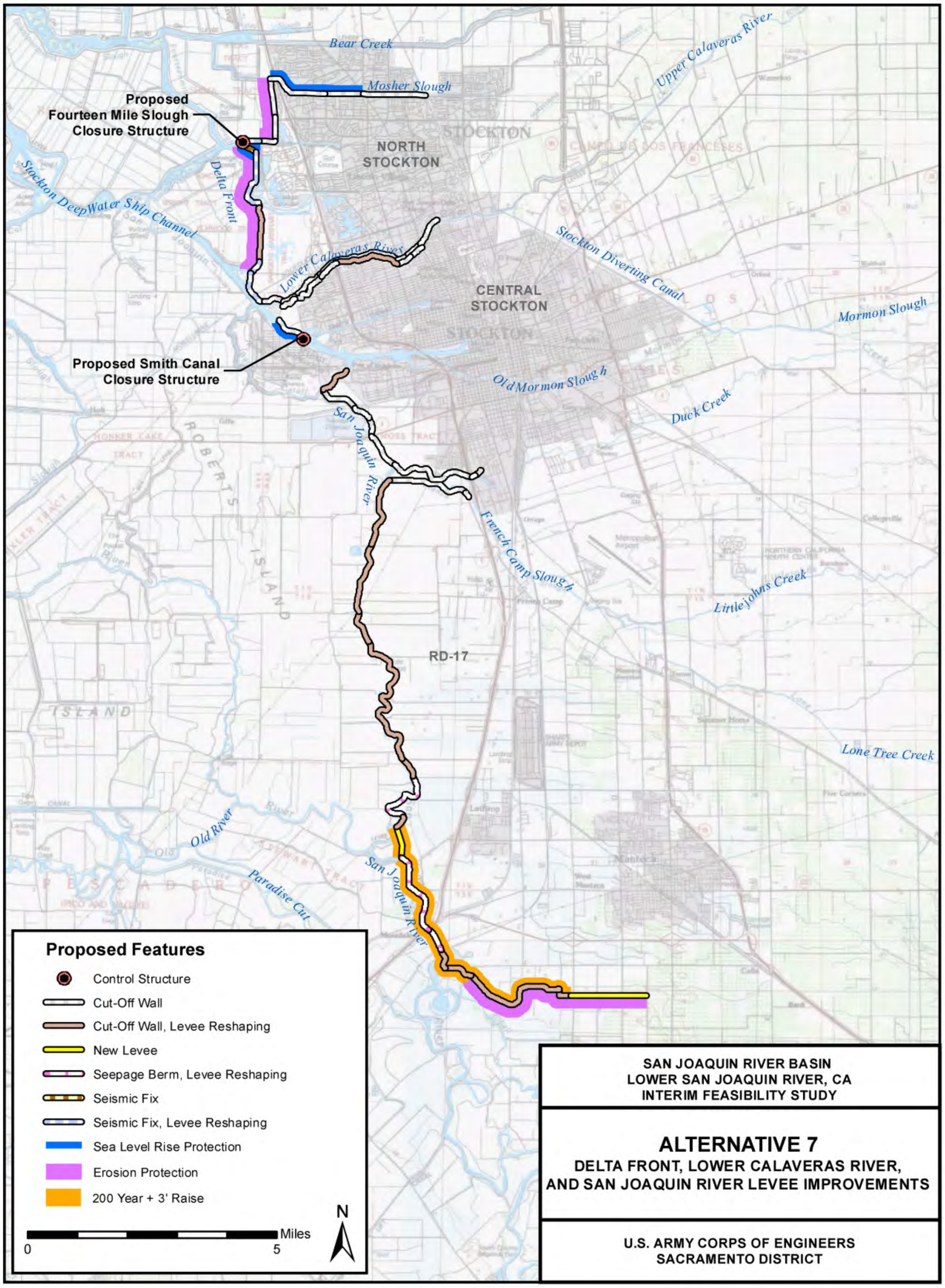
ALTERNATIVE 2B



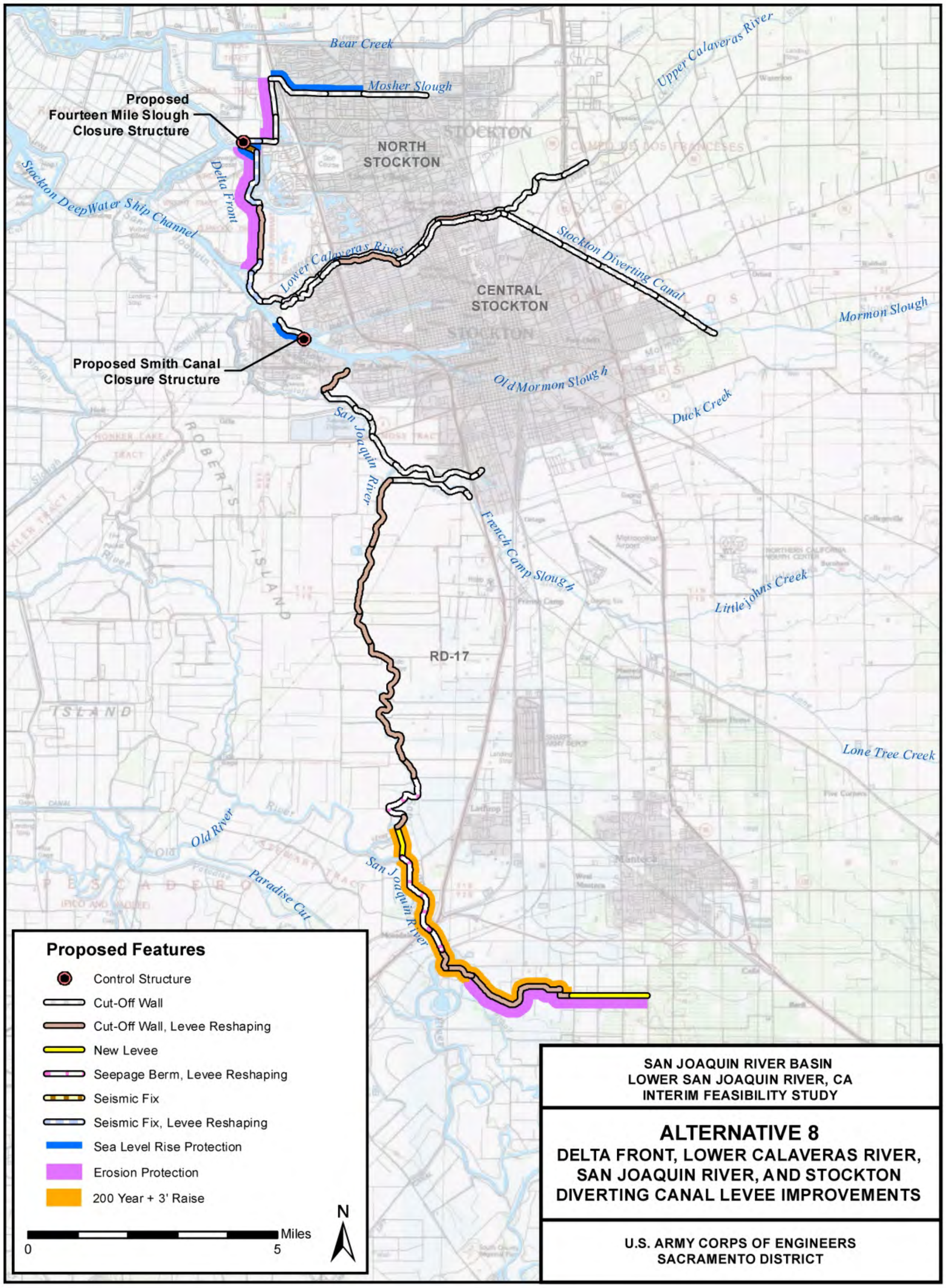
ALTERNATIVE 4



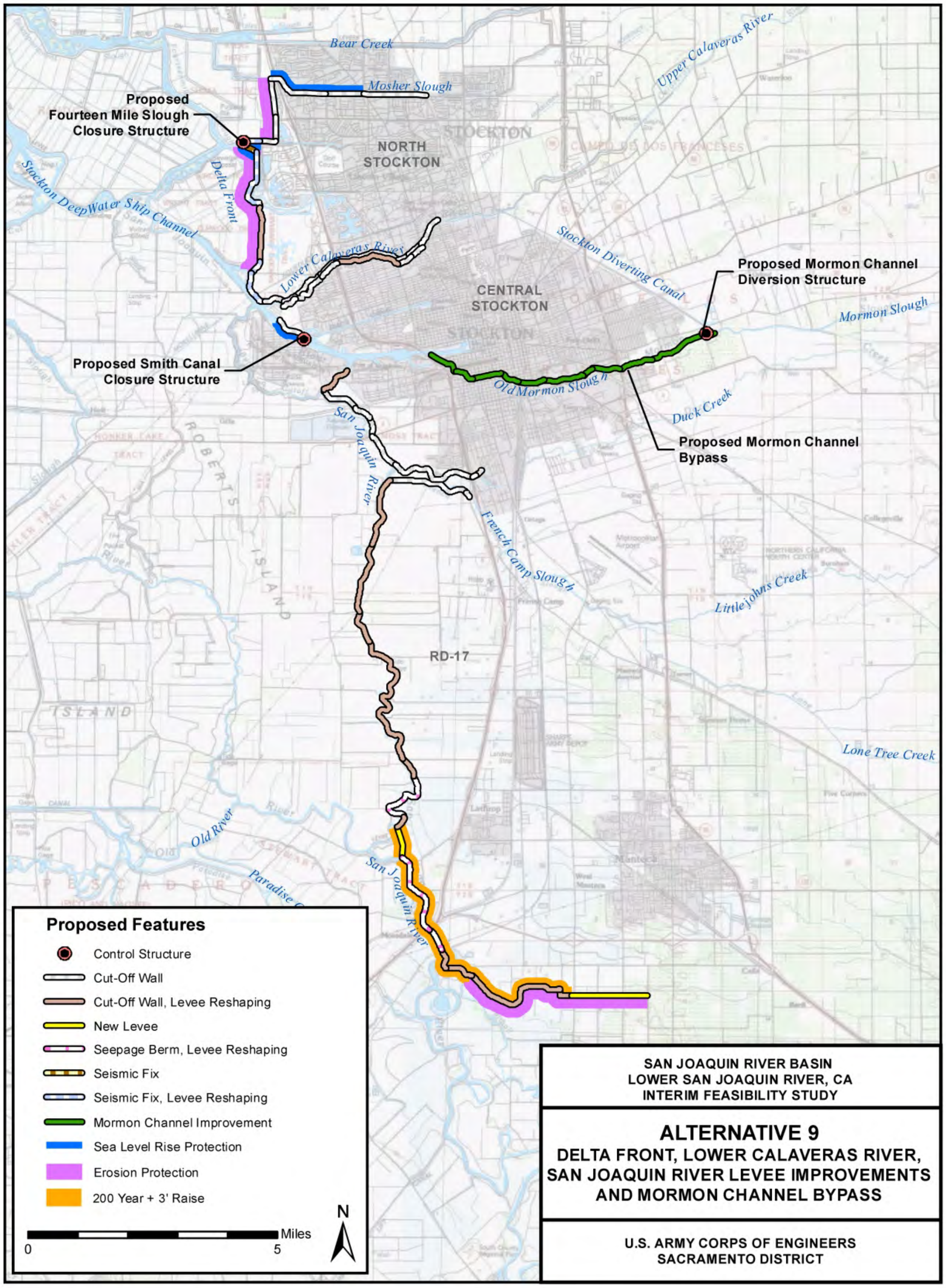
ALTERNATIVE 7



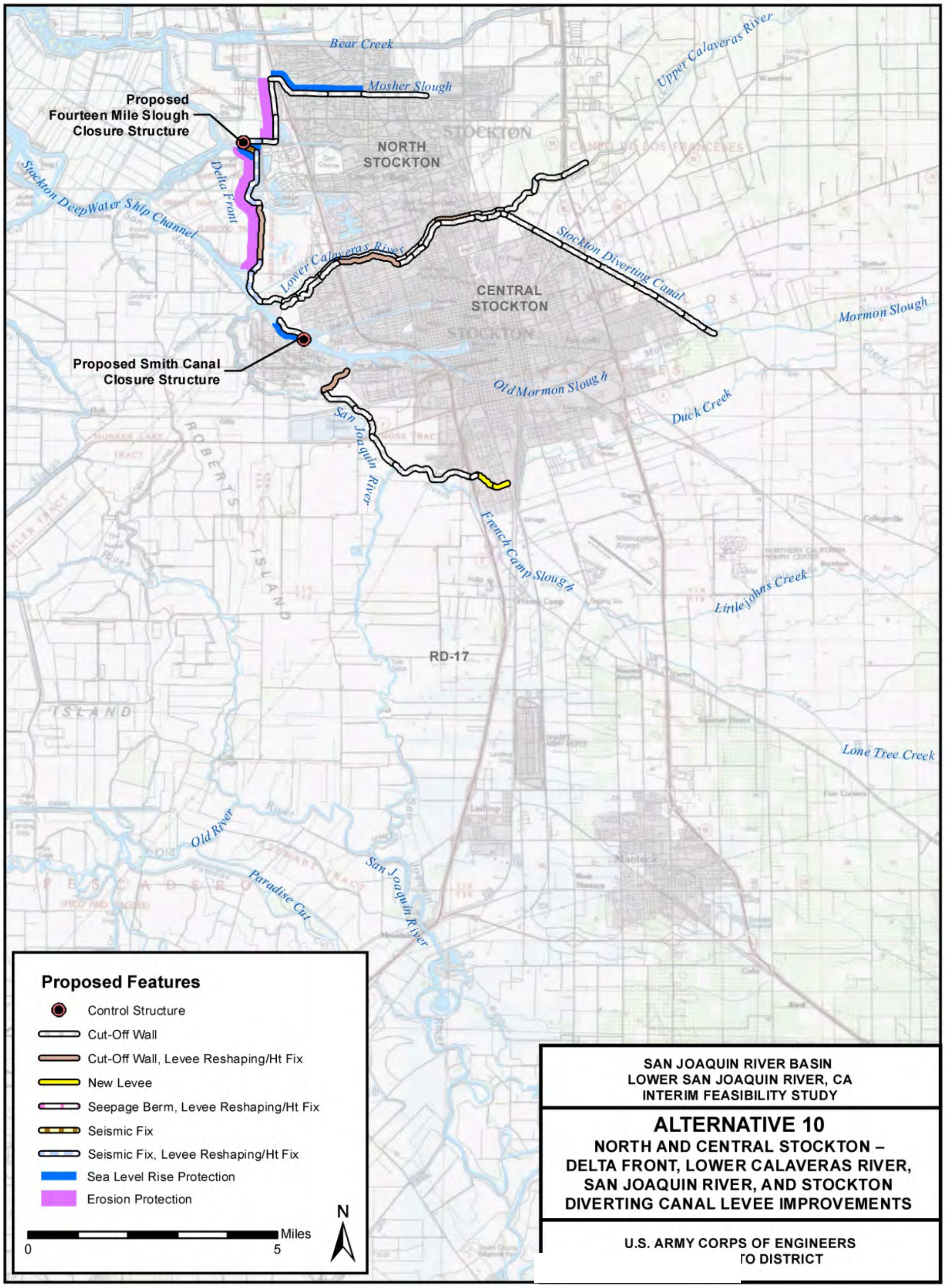
ALTERNATIVE 8



ALTERNATIVE 9



ALTERNATIVE 10



ATTACHMENT 9: IDC AND BDC CALCULATIONS

Alternative LS-7a

INTEREST RATE	3.500%	ALTERNATIVE	LS-7a				
PERIOD	50	TOTAL IDC	$222,331,136	FIX	START YEAR	END YEAR	TOTAL FIRST COST
CONSTRUCTION YEAR	2017	IDC ANNUAL EQUIVALENT	$9,478,801	North Stockton	2018	2028	$627,088,544
BASE YEAR	2028	TOTAL BDC	$812,553,213	Central Stockton	2017	2020	$214,053,622
CRF	0.042634	BDC ANNUAL EQUIVALENT	$34,642,158	RD 17	2018	2028	$0

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-11	2017	1.459970	$71,351,207	$0	$0	$0	$71,351,207	$0	$104,170,602	$0
-10	2018	1.410599	$134,060,062	$0	$0	$0	$134,060,062	$0	$189,104,957	$0
-9	2019	1.362897	$134,060,062	$0	$0	$0	$134,060,062	$0	$182,710,103	$0
-8	2020	1.316809	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$82,575,586	$114,210,161
-7	2021	1.272279	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$79,783,175	$110,347,982
-6	2022	1.229255	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$77,085,193	$106,616,407
-5	2023	1.187686	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$74,478,448	$103,011,022
-4	2024	1.147523	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$71,959,853	$99,527,557
-3	2025	1.108718	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$69,526,428	$96,161,891
-2	2026	1.071225	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$67,175,293	$92,910,039
-1	2027	1.035000	$62,708,854	$86,732,516	$0	$0	$62,708,854	$86,732,516	$64,903,664	$89,768,154
0	2028	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

ALTERNATIVE LS-8

INTEREST RATE	3.500%	ALTERNATIVE	LS-8a	FIX	START YEAR	END YEAR	TOTAL FIRST COST
PERIOD	50	TOTAL IDC	$263,231,321	North Stockton	2018	2028	$669,445,471
CONSTRUCTION YEAR	2017	IDC ANNUAL EQUIVALENT	$11,222,528	Central Stockton	2017	2020	$291,463,223
BASE YEAR	2028	TOTAL BDC	$827,137,984	RD 17	2018	2028	$0
CRF	0.042634	BDC ANNUAL EQUIVALENT	$35,263,961				

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-11	2017	1.459970	$97,154,408	$0	$0	$0	$97,154,408	$0	$141,842,493	$0
-10	2018	1.410599	$164,098,955	$0	$0	$0	$164,098,955	$0	$231,477,782	$0
-9	2019	1.362897	$164,098,955	$0	$0	$0	$164,098,955	$0	$223,650,031	$0
-8	2020	1.316809	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$88,153,185	$116,260,155
-7	2021	1.272279	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$85,172,159	$112,328,652
-6	2022	1.229255	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$82,291,941	$108,530,098
-5	2023	1.187686	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$79,509,122	$104,859,998
-4	2024	1.147523	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$76,820,408	$101,314,008
-3	2025	1.108718	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$74,222,616	$97,887,931
-2	2026	1.071225	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$71,712,672	$94,577,711
-1	2027	1.035000	$66,944,547	$88,289,305	$0	$0	$66,944,547	$88,289,305	$69,287,606	$91,379,431
0	2028	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

ALTERNATIVE LS-9A

INTEREST RATE	3.500%	ALTERNATIVE	LS-9a					
PERIOD	50	TOTAL IDC	$235,893,759	FIX	START YEAR	END YEAR	TOTAL FIRST COST
CONSTRUCTION YEAR	2017	IDC ANNUAL EQUIVALENT	$10,057,026	North Stockton	2018	2028	$617,026,815
BASE YEAR	2028	TOTAL BDC	$819,119,713	Central Stockton	2017	2020	$252,282,092
CRF	0.042634	BDC ANNUAL EQUIVALENT	$34,922,112	RD 17	2018	2028	$0

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-11	2017	1.459970	$84,094,031	$0	$0	$0	$84,094,031	$0	$122,774,738	$0
-10	2018	1.410599	$145,796,712	$0	$0	$0	$145,796,712	$0	$205,660,661	$0
-9	2019	1.362897	$145,796,712	$0	$0	$0	$145,796,712	$0	$198,705,953	$0
-8	2020	1.316809	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$81,250,649	$115,133,129
-7	2021	1.272279	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$78,503,042	$111,239,739
-6	2022	1.229255	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$75,848,350	$107,478,008
-5	2023	1.187686	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$73,283,430	$103,843,486
-4	2024	1.147523	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$70,805,246	$100,331,871
-3	2025	1.108718	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$68,410,866	$96,939,006
-2	2026	1.071225	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$66,097,455	$93,660,875
-1	2027	1.035000	$61,702,682	$87,433,429	$0	$0	$61,702,682	$87,433,429	$63,862,275	$90,493,599
0	2028	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

ALTERNATIVE 7B

INTEREST RATE	**3.500%**	ALTERNATIVE	LS-7b	**FIX**	**START YEAR**	**END YEAR**	**TOTAL FIRST COST**
PERIOD	**50**	TOTAL IDC	$337,967,947				
CONSTRUCTION YEAR	**2017**	IDC ANNUAL EQUIVALENT	$14,408,827	North Stockton	2018	2028	$599,662,745
BASE YEAR	**2030**	TOTAL BDC	$1,470,087,291	Central Stockton	2017	2020	$204,029,427
CRF	0.042634	BDC ANNUAL EQUIVALENT	$62,675,275	RD 17	2024	2030	$410,052,683

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-13	2017	1.563956	$68,009,809	$0	$0	$0	$68,009,809	$0	$106,364,353	$0
-12	2018	1.511069	$127,976,084	$0	$0	$0	$127,976,084	$0	$193,380,649	$0
-11	2019	1.459970	$127,976,084	$0	$0	$0	$127,976,084	$0	$186,841,207	$0
-10	2020	1.410599	$59,966,275	$90,119,406	$0	$0	$59,966,275	$90,119,406	$84,588,353	$127,122,322
-9	2021	1.362897	$59,966,275	$90,119,406	$0	$0	$59,966,275	$90,119,406	$81,727,877	$122,823,500
-8	2022	1.316809	$59,966,275	$90,119,406	$0	$0	$59,966,275	$90,119,406	$78,964,132	$118,670,048
-7	2023	1.272279	$59,966,275	$90,119,406	$0	$0	$59,966,275	$90,119,406	$76,293,848	$114,657,051
-6	2024	1.229255	$128,308,388	$90,119,406	$0	$0	$128,308,388	$90,119,406	$157,723,770	$110,779,760
-5	2025	1.187686	$128,308,388	$90,119,406	$0	$0	$128,308,388	$90,119,406	$152,390,116	$107,033,584
-4	2026	1.147523	$128,308,388	$90,119,406	$0	$0	$128,308,388	$90,119,406	$147,236,827	$103,414,091
-3	2027	1.108718	$128,308,388	$90,119,406	$0	$0	$128,308,388	$90,119,406	$142,257,804	$99,916,996
-2	2028	1.071225	$68,342,114	$268,570,517	$0	$0	$68,342,114	$268,570,517	$73,209,781	$287,699,452
-1	2029	1.035000	$68,342,114	$268,570,517	$0	$0	$68,342,114	$268,570,517	$70,734,088	$277,970,485
0	2030	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

ALTERNATIVE 8B

INTEREST RATE	3.500%	ALTERNATIVE	LS-8b	FIX	START YEAR	END YEAR	TOTAL FIRST COST
PERIOD	50	TOTAL IDC	$390,037,243	North Stockton	2018	2028	$643,644,882
CONSTRUCTION YEAR	2017	IDC ANNUAL EQUIVALENT	$16,628,735	Central Stockton	2017	2020	$279,993,296
BASE YEAR	2030	TOTAL BDC	$1,492,356,211	RD 17	2024	2030	$409,873,204
CRF	0.042634	BDC ANNUAL EQUIVALENT	$63,624,681				

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-13	2017	1.563956	$93,331,099	$0	$0	$0	$93,331,099	$0	$145,965,737	$0
-12	2018	1.511069	$157,695,587	$0	$0	$0	$157,695,587	$0	$238,288,859	$0
-11	2019	1.459970	$157,695,587	$0	$0	$0	$157,695,587	$0	$230,230,781	$0
-10	2020	1.410599	$64,364,488	$91,676,195	$0	$0	$64,364,488	$91,676,195	$90,792,467	$129,318,327
-9	2021	1.362897	$64,364,488	$91,676,195	$0	$0	$64,364,488	$91,676,195	$87,722,191	$124,945,244
-8	2022	1.316809	$64,364,488	$91,676,195	$0	$0	$64,364,488	$91,676,195	$84,755,740	$120,720,042
-7	2023	1.272279	$64,364,488	$91,676,195	$0	$0	$64,364,488	$91,676,195	$81,889,604	$116,637,722
-6	2024	1.229255	$132,676,689	$91,676,195	$0	$0	$132,676,689	$91,676,195	$163,093,527	$112,693,451
-5	2025	1.187686	$132,676,689	$91,676,195	$0	$0	$132,676,689	$91,676,195	$157,578,287	$108,882,561
-4	2026	1.147523	$132,676,689	$91,676,195	$0	$0	$132,676,689	$91,676,195	$152,249,552	$105,200,542
-3	2027	1.108718	$132,676,689	$91,676,195	$0	$0	$132,676,689	$91,676,195	$147,101,017	$101,643,036
-2	2028	1.071225	$68,312,201	$271,725,616	$0	$0	$68,312,201	$271,725,616	$73,177,737	$291,079,273
-1	2029	1.035000	$68,312,201	$271,725,616	$0	$0	$68,312,201	$271,725,616	$70,703,128	$281,236,013
0	2030	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

ALTERNATIVE 9B

INTEREST RATE	3.500%	ALTERNATIVE	LS-9b	FIX	START YEAR	END YEAR	TOTAL FIRST COST
PERIOD	50	TOTAL IDC	$355,176,353	North Stockton	2018	2028	$593,738,462
CONSTRUCTION YEAR	2017	IDC ANNUAL EQUIVALENT	$15,142,485	Central Stockton	2017	2020	$242,171,508
BASE YEAR	2030	TOTAL BDC	$1,478,835,155	RD 17	2024	2030	$406,001,626
CRF	0.042634	BDC ANNUAL EQUIVALENT	$63,048,228				

PERIOD	YEAR	PRESENT WORTH FACTOR	COSTS PRIOR TO BASE	BENEFITS PRIOR TO BASE	COSTS PERIOD OF ANALYSIS	BENEFITS PERIOD OF ANALYSIS	TOTAL COSTS	TOTAL BENEFITS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS
-13	2017	1.563956	$80,723,836	$0	$0	$0	$80,723,836	$0	$126,248,532	$0
-12	2018	1.511069	$140,097,682	$0	$0	$0	$140,097,682	$0	$211,697,216	$0
-11	2019	1.459970	$140,097,682	$0	$0	$0	$140,097,682	$0	$204,538,373	$0
-10	2020	1.410599	$59,373,846	$90,820,319	$0	$0	$59,373,846	$90,820,319	$83,752,674	$128,111,029
-9	2021	1.362897	$59,373,846	$90,820,319	$0	$0	$59,373,846	$90,820,319	$80,920,458	$123,778,772
-8	2022	1.316809	$59,373,846	$90,820,319	$0	$0	$59,373,846	$90,820,319	$78,184,017	$119,593,017
-7	2023	1.272279	$59,373,846	$90,820,319	$0	$0	$59,373,846	$90,820,319	$75,540,113	$115,548,809
-6	2024	1.229255	$127,040,784	$90,820,319	$0	$0	$127,040,784	$90,820,319	$156,165,560	$111,641,361
-5	2025	1.187686	$127,040,784	$90,820,319	$0	$0	$127,040,784	$90,820,319	$150,884,599	$107,866,049
-4	2026	1.147523	$127,040,784	$90,820,319	$0	$0	$127,040,784	$90,820,319	$145,782,221	$104,218,405
-3	2027	1.108718	$127,040,784	$90,820,319	$0	$0	$127,040,784	$90,820,319	$140,852,388	$100,694,111
-2	2028	1.071225	$67,666,938	$269,384,136	$0	$0	$67,666,938	$269,384,136	$72,486,515	$288,571,021
-1	2029	1.035000	$67,666,938	$269,384,136	$0	$0	$67,666,938	$269,384,136	$70,035,280	$278,812,581
0	2030	1.000000	$0	$0	$0	$0	$0	$0	$0	$0

US Army Corps of Engineers®

Sacramento District
Planning Division

Lower San Joaquin River Feasibility Report

San Joaquin County, California

OTHER SOCIAL EFFECTS
REGIONAL ECONOMIC DEVELOPMENT

This page intentionally left blank

INTRODUCTION

In the past, planning studies at the Corps of Engineers have focused primarily on the National Economic Development (NED) account to formulate and evaluate water resource infrastructure projects. In recent years, however, there has been a renewed emphasis on considering the Other Social Effects (OSE), Regional Economic Development (RED), and Environmental Quality (EQ) accounts when making investment decisions, as can be seen in the publication of Engineering Circular (EC) 1105-2-409, "Planning in a Collaborative Environment." EC 1105-2-409 encourages the use of all four accounts in order to develop water resource solutions that are more holistic and acceptable, and which take into account both national and local stakeholder interests.

The following sections describe the OSE and RED assessments developed for the Lower San Joaquin River Feasibility Study (LSJRFS).

Contents

Tables

Figures

PART I — OTHER SOCIAL EFFECTS

The objective of the Other Social Effects (OSE) assessment is to provide a portrait of the social landscape of the Lower San Joaquin Feasibility Study area and offer a glimpse into the potential vulnerability of the people who live there. Table 1 below summarizes the elements commonly included in the OSE account and the metrics used to evaluate them.

TABLE 1: ELEMENTS OF OSE ANALYSIS

SOCIAL ELEMENT	METRICS
Social connectedness	Gender, race, ethnicity, age, rural versus urban communities, rental versus owner-occupied dwellings, and occupation
Community social capital	Education, family structure, rural vs. urban communities, and population growth
Community resilience	Income, political power, neighborhood prestige, employment loss, residential property characteristics, infrastructure and lifelines, family structure, and medical services

This assessment compares the other social effects associated with the without-project and with-project conditions. The 1% annual chance exceedance (ACE) floodplain serves as the baseline to assess effects.

CURRENT SOCIAL LANDSCAPE

Describing the social landscape of the area provides an understanding of who lives in the study area, who has a stake in the problem or issue, and why it is important to them. A demographic profile of the area is performed using social statistics, and the information is presented in a meaningful way through the use of comparisons and rankings. It is important to note that the profile itself is not an OSE analysis but rather a data collection step that provides a basic level of understanding about the social conditions in the area; the data provides input into a more in-depth analysis that targets areas of special concern or relevance to the water resources issue at hand. The basic social statistics of the study area are summarized in Table 2 below. These statistics, along with the social elements listed in Table 1, are indicators used to portray basic information about the social life and the processes of the study area.

TABLE 2: BASIC SOCIAL CHARACTERISTICS OF THE STUDY AREA

SOCIAL STATISTIC	STOCKTON			CALIFORNIA		
	2000	2010	% Δ	2000	2010	% Δ
Population						
Total	243,771	291,707	19.7%	33,871,648	37,253,956	10%
Age						
Median	29.8	30.8	3.4%	33.3	35.2	5.70%
% >65	10.20%	10.00%	-2.0%	10.60%	11.40%	7.50%
% <18	32.40%	29.90%	-7.7%	27.30%	25.00%	-8.40%
Race & Ethnicity						
Asian	19.90%	21.50%	8.0%	10.90%	12.80%	17.40%
Black	11.20%	12.20%	8.9%	6.70%	5.80%	-13.40%
Hispanic	32.50%	40.30%	24.0%	32.40%	37.60%	16%
White	32.20%	22.90%	-28.9%	46.70%	40.10%	-14.10%
Other	4.20%	3.10%	-26.2%	4.30%	3.70%	86%
Education						
% HS Graduates	68.2%	73.70%	8.1%	81%	80.80%	-0.20%
% College Graduates	15.4%	17.50%	13.6%	30.50%	30.20%	-0.90%
Income and Poverty						
% Unemployed	7.3%	10.50%	43.8%	4.30%	7.10%	65.00%
Median Household Income	35,453	$47,246	33.3%	61,400	61,632	0.00%
% Below Poverty	38.4%	23.30%	-39.3%	15.30%	14.40%	-5.90%
Housing						
% Own	51.60%	51.90%	0.6%	56%	55.90%	0%
% Rent	48.40%	48.10%	-0.6%	44%	44.10%	0%
Quality of Life						
Avg. Household Size	3.04	3.17	4.3%	2.98	3.45	16%
Language Other than English Spoken at Home	41.5%	45.1%	8.7%	43.50%	43.20%	-0.70%
Mean Travel Time to Work (minutes)	27.2	26.4	-2.9%	27.1	27	-0.40%

Source: US Census Bureau

SOCIAL EFFECTS ASSESSMENT

A social effects assessment considers the social vulnerability and resiliency of a population. Social vulnerability refers to the sensitivity of a population to natural hazards, whereas social resiliency refers to the population's ability to respond to and recover from the impacts of a natural hazard. The characteristics that are recognized as having an influence on social vulnerability and resiliency generally include age, gender, race, and socioeconomic status as well as population segments with special needs or those without the normal social safety nets typically necessary to recover from a disaster. The quality of human settlements (e.g., housing type and construction, infrastructure, and lifelines) and the built environment also play an important role in assessing social vulnerability and resiliency, especially as these characteristics influence potential economic losses, injuries, and fatalities from natural hazards. The two tables below provide a discussion of factors that may influence social vulnerability and resiliency and also provides a qualitative assessment of the Lower San Joaquin River Feasibility study area based on indicator statistics from the 2010 U.S. Census. The discussion column is from the article, *Social Vulnerability to Environmental Hazards*, which was published in the June 2003 edition of Social Science Quarterly.

INDICATOR	DISCUSSION	ASSESSMENT
Income, political power, and prestige	This measure focuses on the ability to absorb losses and enhance resilience to hazard impacts. Wealth enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs.	The median household income of the area is 30% less than the median for the state of California; however, the city's proximity to the state's Capital of Sacramento may provide significant access to of political resources.
Gender	Women can have a more difficult time during recovery than men, often due to sector-specific employment, lower wages, and family care responsibilities.	Women make up 46.0% of the work force while men make up 54.0%; the median income for women in the area is $42,824, which is 89% of the median income for men.
Race and Ethnicity	Race and ethnicity may impose language and cultural barriers that affect access to post-disaster funding	The area is highly diverse in terms of race and ethnicity. Over 40% of the residents speak a language other than English at home; this may contribute to the vulnerability and possibly the resiliency of the community.
Age	Extremes on the age spectrum inhibit the movement out of harm's way. Parents lose time and money caring for children when daycare facilities are affected; the elderly may have mobility constraints or mobility concerns increasing the burden of care and lack of resilience.	Those age 65 and over make up a slightly lower percentage of the community's population as compared to the percentage for the same age category for the state as a whole; the percentage of residents younger than 18 (29.9%) is slightly higher than the state statistic (25%).
Employment Loss	The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster.	The latest Census indicates that the current unemployment rate in the area may be significantly higher than the state's. A flood event which causes additional unemployment may exacerbate the current unemployment rate.
Rural/Urban	Rural residents may be more vulnerable due to lower incomes, and may be more dependent on locally-based resource extraction economies (farming and fishing). High-density areas (urban) complicate evacuation from harm's way.	The area is highly urbanized and close to many resources.
Residential Property	The value, quality, and density of residential construction affect potential losses and recovery. For example, expensive homes are costly to replace, while mobile homes are easily destroyed and less resilient to hazards.	The area is comprised of a full spectrum of homes – from average quality to excellent. Medium density neighborhoods are typical, with higher density neighborhoods in the downtown area.
Infrastructure and Lifelines	Loss of sewers, bridges, water, communications, and transportation infrastructure may place an insurmountable financial burden on the smaller communities that lack the financial resources to rebuild.	Many of the neighborhoods within the study area are well-established and would most likely have access to the many resources available within the city itself as well as within the greater Sacramento area to the north.

INDICATOR	DISCUSSION	ASSESSMENT
Renters	People that rent typically do so because they are either transient or do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.	The number of rentals in the area is significant (about 48%), and is higher than the state average of about 44%. The high rental population may contribute to communication cohesion issues; research indicates that renters do not have the same level of community pride as owners do, which may lead to more challenges in redeveloping a community after a flood event.
Occupation	Some occupations, especially those of resource extraction, may be severely impacted by a hazard event. Self-employed fishermen suffer when their means of production is lost and may not have the requisite capital to resume work in a timely fashion and thus will seek alternative employment. Migrant workers engaged in agriculture and low skilled service jobs (e.g., housekeeping, childcare, and gardening) may similarly suffer, as disposable income fades and the need for services decline. Immigration status also affects occupational recovery.	The number of people that live in the area and work in resource extraction occupations is fairly low; the 2010 Census indicates that around 4,329 people (or 3.2% of the total work force) work in the farming, fishing, and forestry occupations.
Family Structure	Families with large numbers of dependents or single-parent households often have limited finances to outsource care for dependents, and thus must juggle work responsibilities and care for family members. All affect the resilience to recover from hazards.	The literature indicates that families having greater than four persons have more financial difficulty than smaller families. Accordingly, community planners need to be aware of issues that may arise.
Education	Education is strongly linked to socioeconomic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information.	Nearly 74% of the population has graduated from high school and 17.5% hold a bachelor's degree.
Population Growth	Counties experiencing rapid growth lack available quality housing; its social services network may not have had time to adjust to increased populations. New migrants may not speak the language and not be familiar with bureaucracies for obtaining relief or recovery information, all of which increases vulnerability.	Stockton has grown considerably over the past 10-15 years. The population has grown by about 20%--nearly double the state's population growth rate. Rapid growth is highly correlated with low community cohesion. The sense of belonging, cooperation, and community pride are dynamic factors which help with community resilience but which may not be as strong in cities that have experienced rapid growth.
Medical Services	Health care providers, including physicians, nursing homes, and hospitals are important post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and result in longer recovery from disasters.	The residents of Stockton would have access to medical facilities in nearby areas, which include the greater Sacramento metropolitan area approximately 45 miles to the north.

LIFE SAFETY EVALUATION

A life safety evaluation was conducted for both the No Action alternative and Alternative LS-7a. Life safety was evaluated based on the following variables: (1) the probability of an annual chance exceedance (ACE) event occurring; (2) the probability of levee failure given the occurrence of an ACE event; (3) the depth of flooding that would occur following a levee failure; and (4) the population density in the flooded area.

Life safety risk was evaluated in two parts. First, a risk matrix was developed based on flood probabilities and inundation depths. Probabilities range from the highly improbable to the very likely, while flood depths range from very shallow to catastrophically deep. The risk matrix and associated qualitative risk factors are shown in Figure 1 below. Table 3 provides plain language explanations of the risk factors that appear in each cell of matrix.

FIGURE 1: FLOOD RISK MATRIX

-RISK-		DEPTH					
		0-1	1-2	2-5	5-10	10-15	15-20
PROBABILITY	1:10,000	VERY LOW	VERY LOW	VERY LOW	LOW	MEDIUM	MEDIUM
	1:1,000	VERY LOW	VERY LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	1:500	VERY LOW	VERY LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	1:250	VERY LOW	LOW	LOW	MEDIUM	HIGH	HIGH
	1:100	LOW	LOW	MEDIUM	HIGH	HIGH	VERY HIGH
	1:25	LOW	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
	1:10	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH

TABLE 3: EXPLANATION OF RISK FACTORS

-RISK-		DEPTH OF FLOODING (FT)					
		0-1	1-2	2-5	5-10	10-15	15-20
PROBABILITY OF EVENT + FAILURE	1:10,000	A 1:10,000 chance of receiving 0-1 feet of flooding in a given year is considered VERY LOW risk.	A 1:10,000 chance of receiving 1-2 feet of flooding in a given year is considered VERY LOW risk.	A 1:10,000 chance of receiving 2-5 feet of flooding in a given year is considered VERY LOW risk.	A 1:10,000 chance of receiving 5-10 feet of flooding in a given year is considered LOW risk.	A 1:10,000 chance of receiving 10-15 feet of flooding in a given year is considered MEDIUM risk.	A 1:10,000 chance of receiving 15-20 feet of flooding in a given year is considered MEDIUM risk.
	1:10,00	A 1:10,00 chance of receiving 0-1 feet of flooding in a given year is considered VERY LOW risk.	A 1:10,00 chance of receiving 1-2 feet of flooding in a given year is considered VERY LOW risk.	A 1:10,00 chance of receiving 2-5 feet of flooding in a given year is considered LOW risk.	A 1:10,00 chance of receiving 5-10 feet of flooding in a given year is considered MEDIUM risk.	A 1:10,00 chance of receiving 10-15 feet of flooding in a given year is considered MEDIUM risk.	A 1:10,00 chance of receiving 15-20 feet of flooding in a given year is considered MEDIUM risk.
	1:500	A 1:500 chance of receiving 0-1 feet of flooding in a given year is considered VERY LOW risk.	A 1:500 chance of receiving 1-2 feet of flooding in a given year is considered VERY LOW risk.	A 1:500 chance of receiving 2-5 feet of flooding in a given year is considered LOW risk.	A 1:500 chance of receiving 5-10 feet of flooding in a given year is considered MEDIUM risk.	A 1:500 chance of receiving 10-15 feet of flooding in a given year is considered MEDIUM risk.	A 1:500 chance of receiving 15-20 feet of flooding in a given year is considered MEDIUM risk.
	1:250	A 1:250 chance of receiving 0-1 feet of flooding in a given year is considered VERY LOW risk.	A 1:250 chance of receiving 1-2 feet of flooding in a given year is considered LOW risk.	A 1:250 chance of receiving 2-5 feet of flooding in a given year is considered LOW risk.	A 1:250 chance of receiving 5-10 feet of flooding in a given year is considered MEDIUM risk.	A 1:250 chance of receiving 10-15 feet of flooding in a given year is considered HIGH risk.	A 1:250 chance of receiving 15-20 feet of flooding in a given year is considered HIGH risk.
	1:100	A 1:100 chance of receiving 0-1 feet of flooding in a given year is considered LOW risk.	A 1:100 chance of receiving 1-2 feet of flooding in a given year is considered LOW risk.	A 1:100 chance of receiving 2-5 feet of flooding in a given year is considered MEDIUM risk.	A 1:100 chance of receiving 5-10 feet of flooding in a given year is considered HIGH risk.	A 1:100 chance of receiving 10-15 feet of flooding in a given year is considered HIGH risk.	A 1:100 chance of receiving 15-20 feet of flooding in a given year is considered VERY HIGH risk.
	1:25	A 1:25 chance of receiving 0-1 feet of flooding in a given year is considered LOW risk.	A 1:25 chance of receiving 1-2 feet of flooding in a given year is considered MEDIUM risk.	A 1:25 chance of receiving 2-5 feet of flooding in a given year is considered MEDIUM risk.	A 1:25 chance of receiving 5-10 feet of flooding in a given year is considered HIGH risk.	A 1:25 chance of receiving 10-15 feet of flooding in a given year is considered VERY HIGH risk.	A 1:25 chance of receiving 15-20 feet of flooding in a given year is considered VERY HIGH risk.
	1:10	A 1:10 chance of receiving 0-1 feet of flooding in a given year is considered MEDIUM risk.	A 1:10 chance of receiving 1-2 feet of flooding in a given year is considered MEDIUM risk.	A 1:10 chance of receiving 2-5 feet of flooding in a given year is considered HIGH risk.	A 1:10 chance of receiving 5-10 feet of flooding in a given year is considered VERY HIGH risk.	A 1:10 chance of receiving 10-15 feet of flooding in a given year is considered VERY HIGH risk.	A 1:10 chance of receiving 15-20 feet of flooding in a given year is considered VERY HIGH risk.

The tables and figures below are provided to compare flood risk to the population of the LSJRFS study area under the No Action alternative and Alternative LS-7a. Tables 4 and 5 list the number of people in each risk category for the existing and future condition. Tables 6 and 7 further illustrate the potential impact of Alternative LS-7a on flood risk by showing the number of people affected by each combination of the No Action alternative and Alternative LS-7a flood risk categories. The maps in figures 2 through 9 show existing and future flood risk for both alternatives based on the probability and depth of flooding.

TABLE 4: POPULATION BY FLOOD RISK CATEGORY—EXISTING CONDITION

FLOOD RISK	ALTERNATIVE	
	NO ACTION	LS-7A
Very Low	53,361	53,910
Low	62,311	63,633
Medium	58,207	82,194
High	48,092	27,717
Very High	5,484	0

TABLE 5: POPULATION BY FLOOD RISK CATEGORY—FUTURE CONDITION

FLOOD RISK	ALTERNATIVE	
	NO ACTION	LS-7A
Very Low	50,594	53,713
Low	59,355	63,831
Medium	50,615	77,937
High	60,837	31,975
Very High	6,054	0

TABLE 6: PROJECT IMPACT ON FLOOD RISK—EXISTING CONDITION

RISK CATEGORY		POPULATION
No Action	LS-7a	
Very High	High	154
Very High	Medium	5,330
High	High	27,563
High	Medium	20,529
Medium	Medium	56,335
Medium	Low	1,872
Low	Low	61,762
Low	Very Low	549
Very Low	Very Low	53,361

TABLE 7: PROJECT IMPACT ON FLOOD RISK—FUTURE CONDITION

RISK CATEGORY		POPULATION
No Action	LS-7a	
Very High	High	284
Very High	Medium	5,771
High	High	31,691
High	Medium	29,146
Medium	Medium	43,020
Medium	Low	7,595
Low	Low	56,236
Low	Very Low	3,119
Very Low	Very Low	50,594

FIGURE 2: FLOOD RISK—STUDY AREA—EXISTING CONDITION

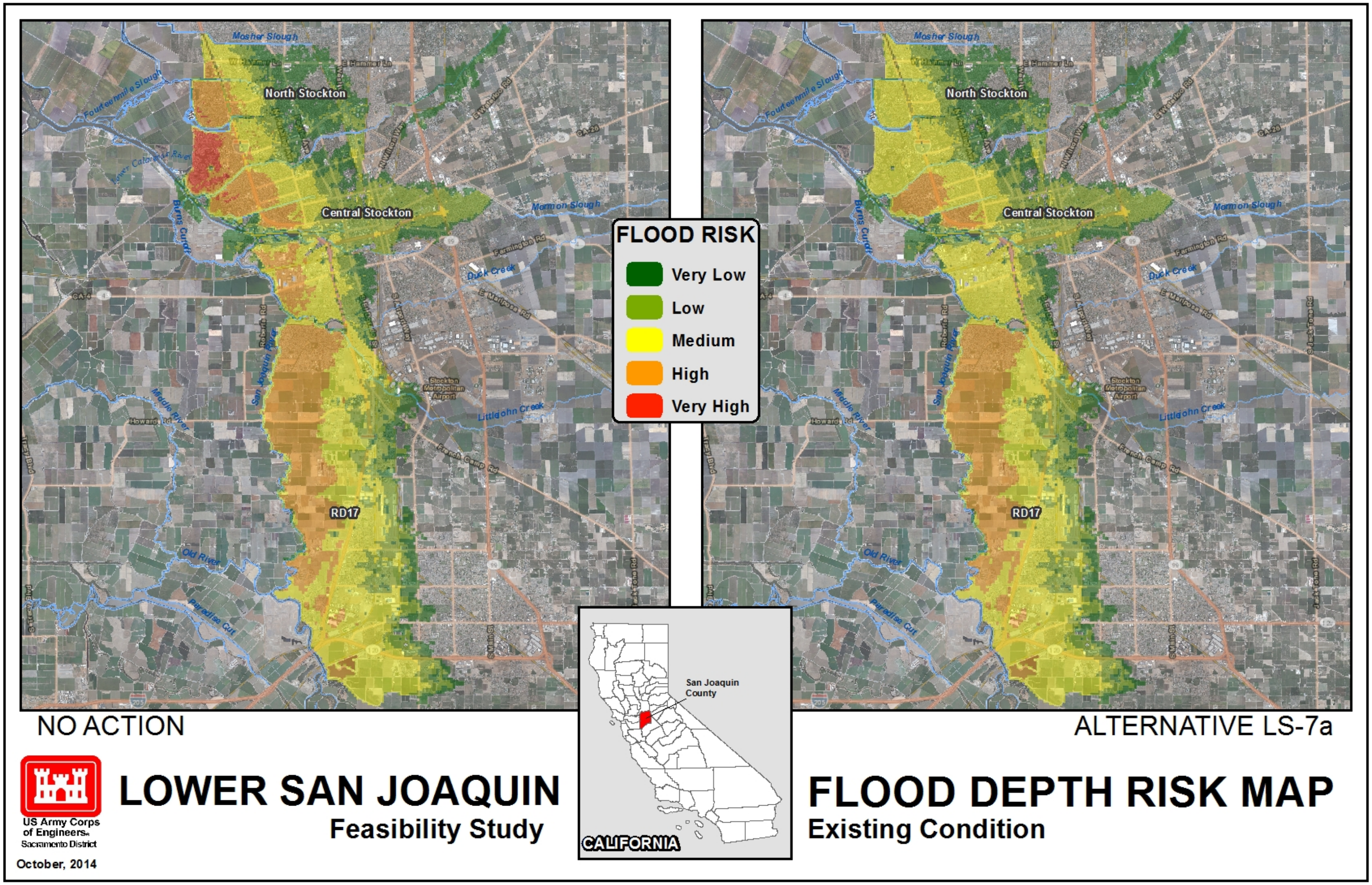


FIGURE 3: FLOOD RISK—STUDY AREA—FUTURE CONDITION

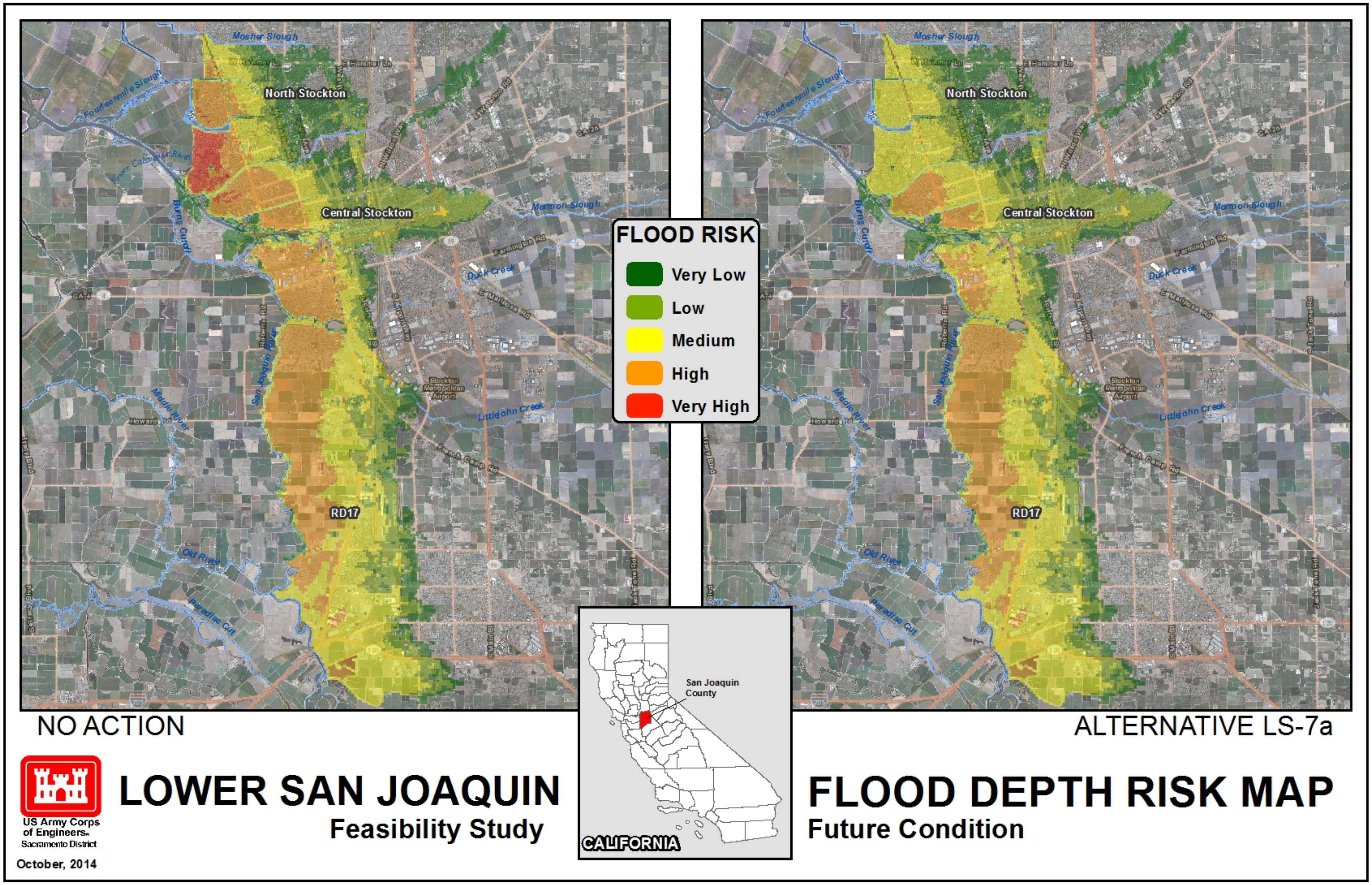


FIGURE 4: FLOOD RISK—NORTH STOCKTON—EXISTING CONDITION

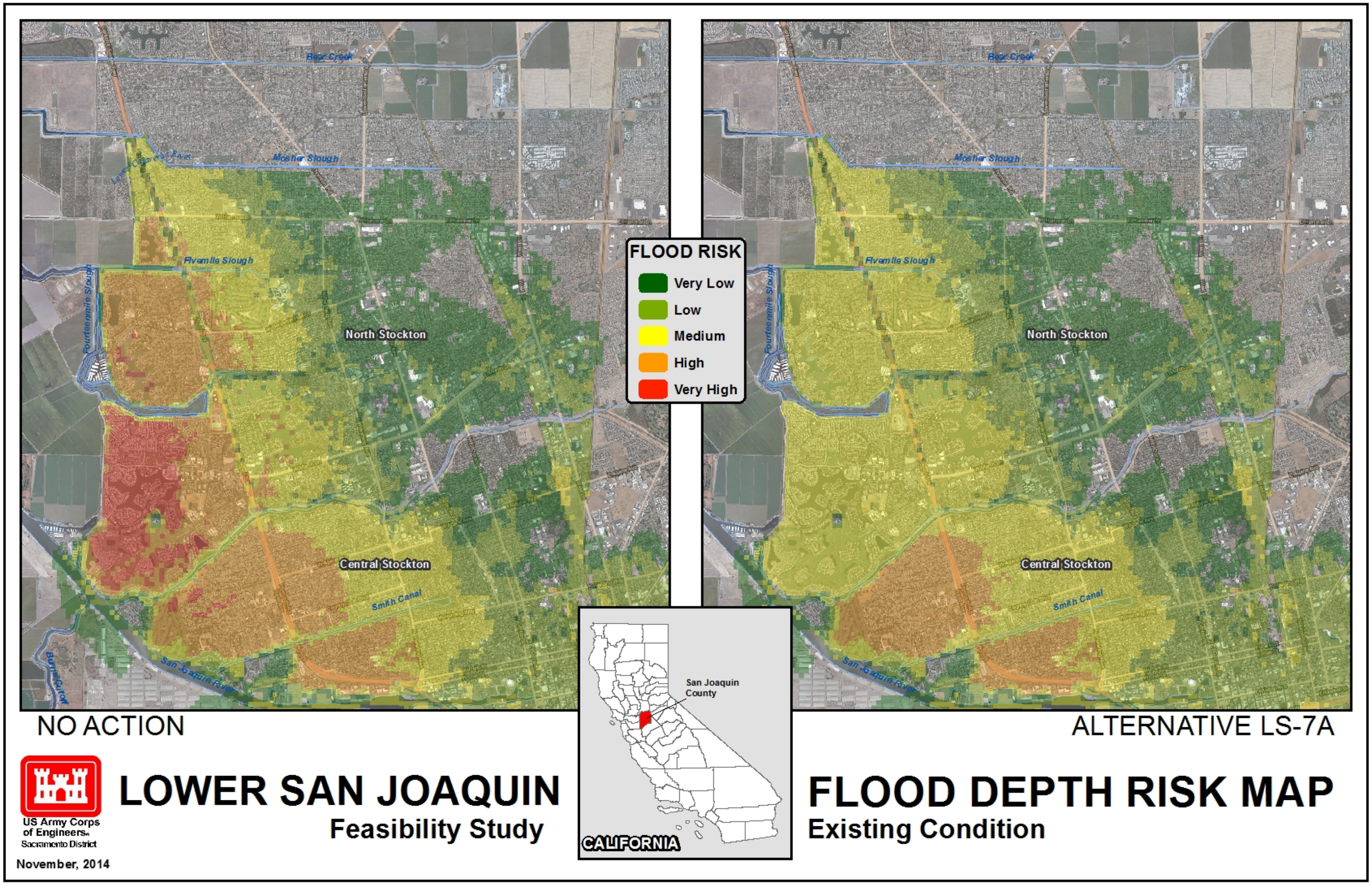


FIGURE 5: FLOOD RISK—NORTH STOCKTON—FUTURE CONDITION

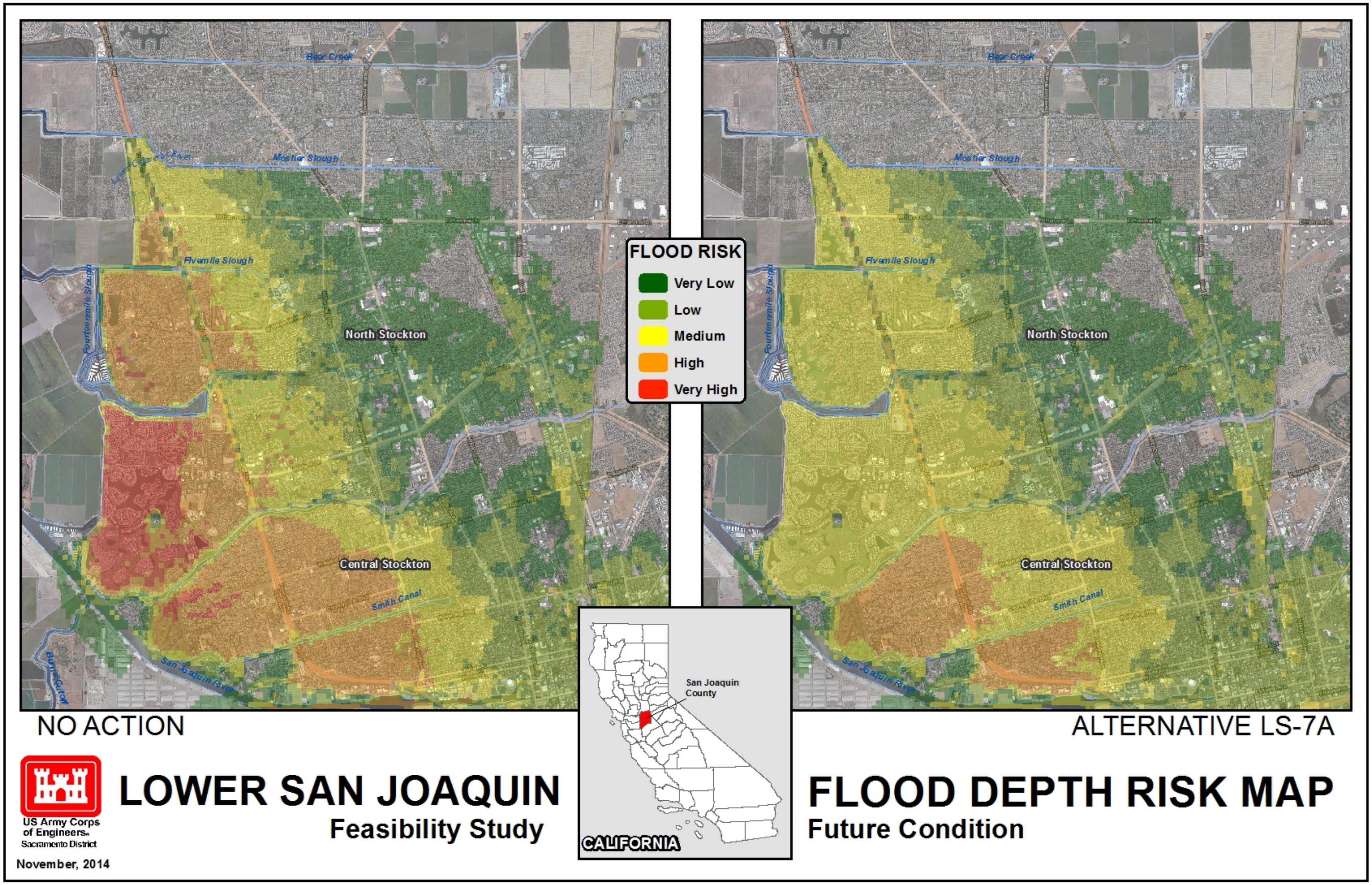


FIGURE 6: FLOOD RISK—CENTRAL STOCKTON—EXISTING CONDITION

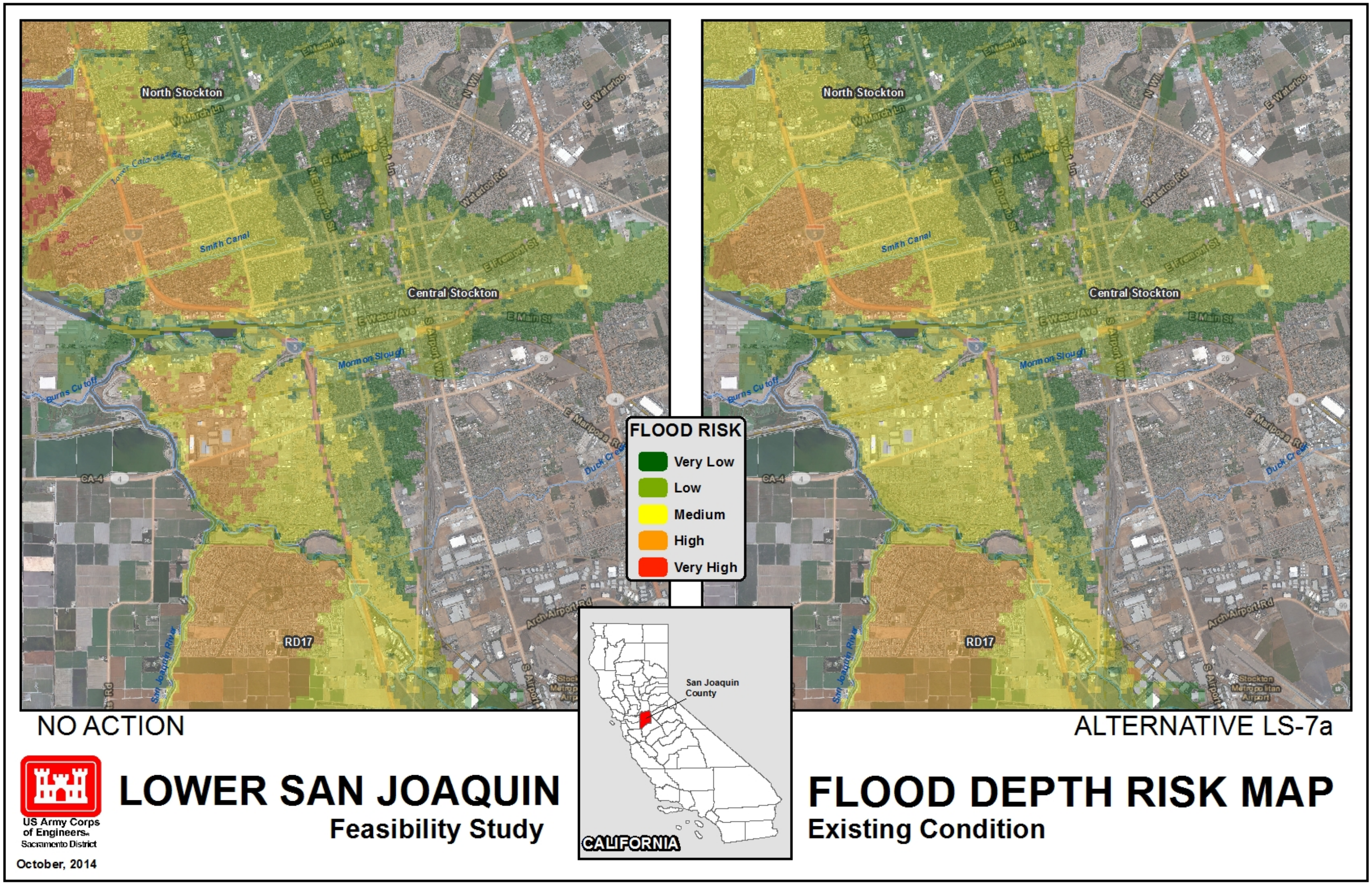


FIGURE 7: FLOOD RISK—CENTRAL STOCKTON—FUTURE CONDITION

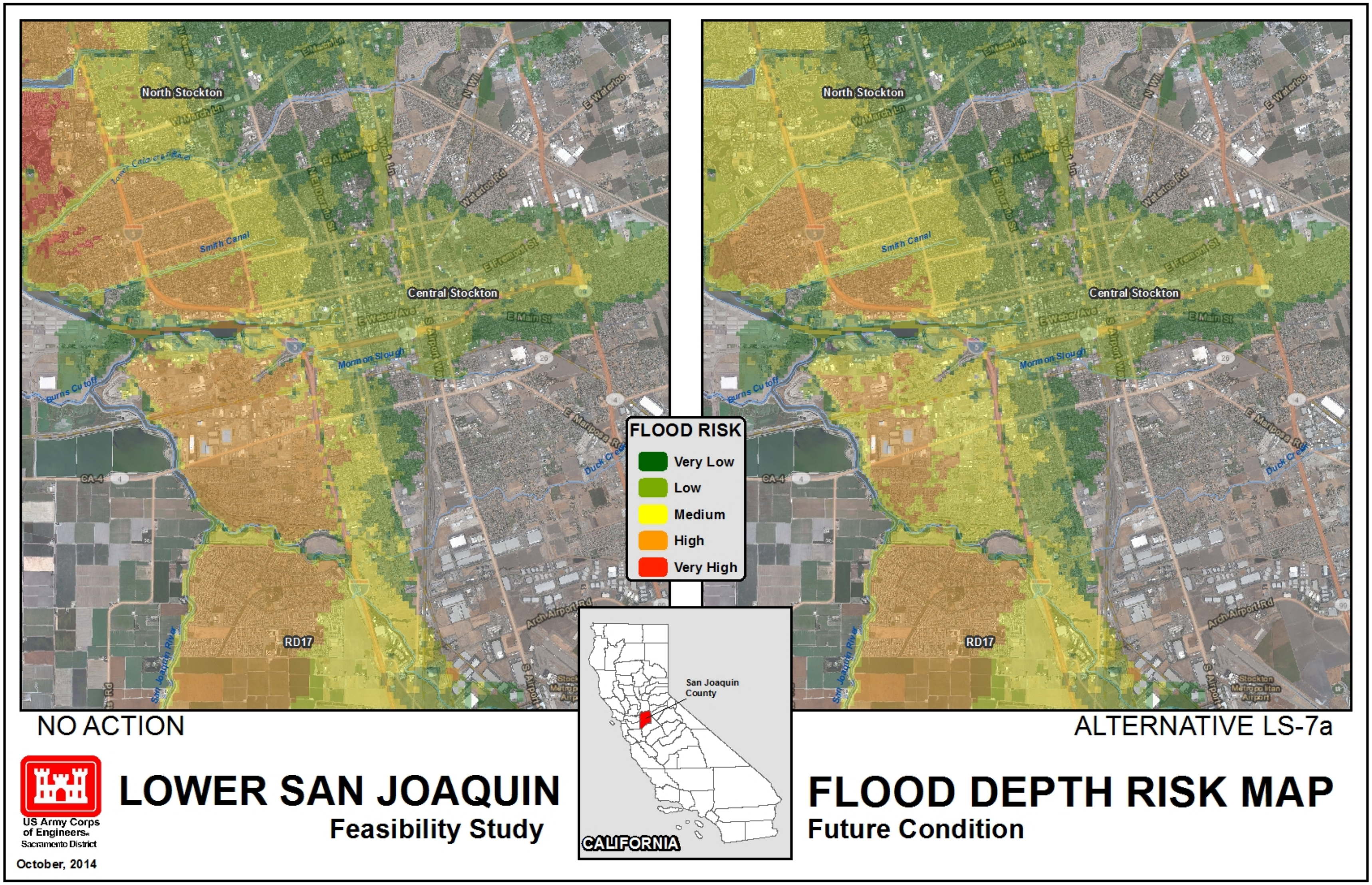


FIGURE 8: FLOOD RISK—RD17—EXISTING CONDITION

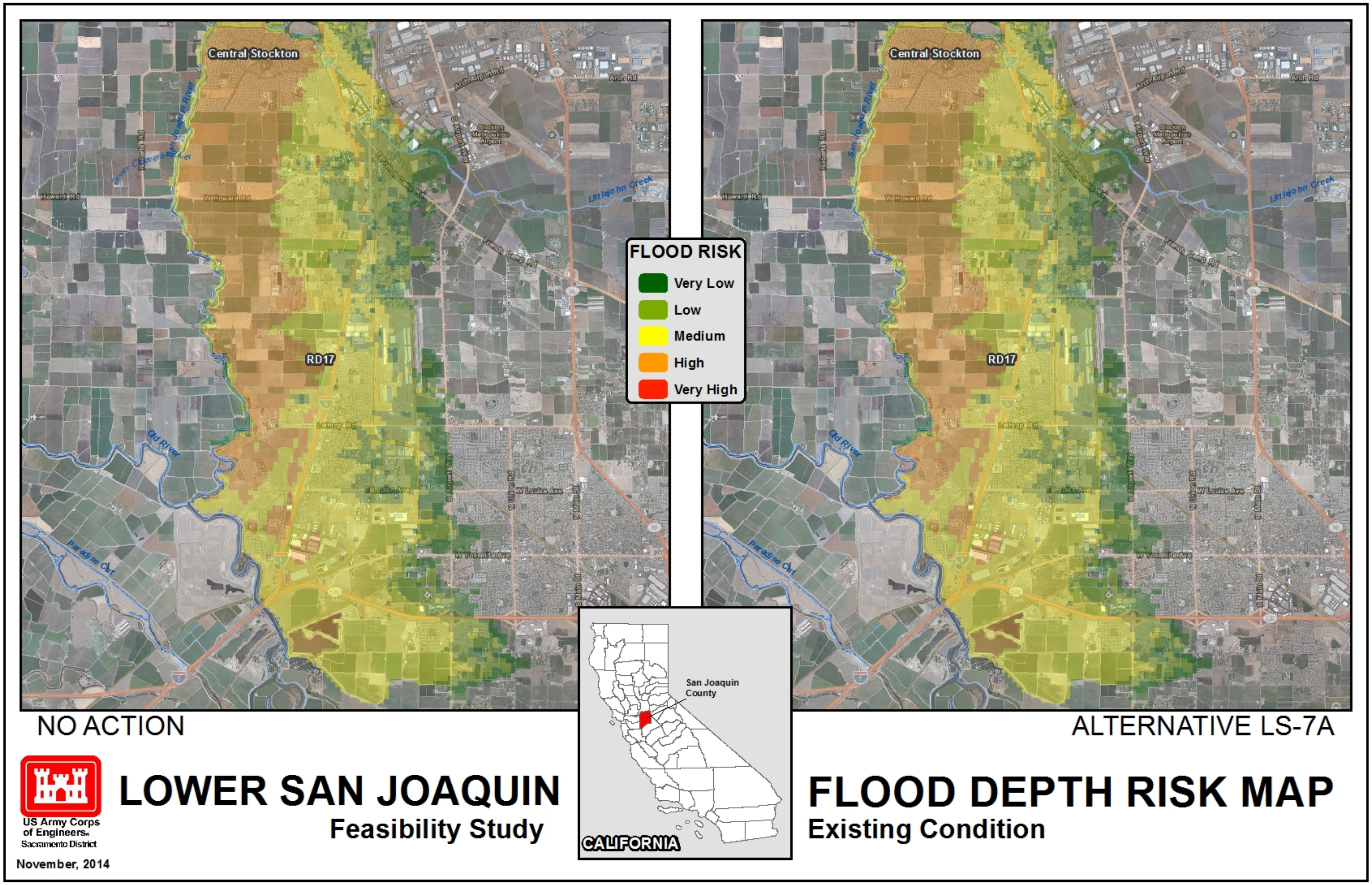
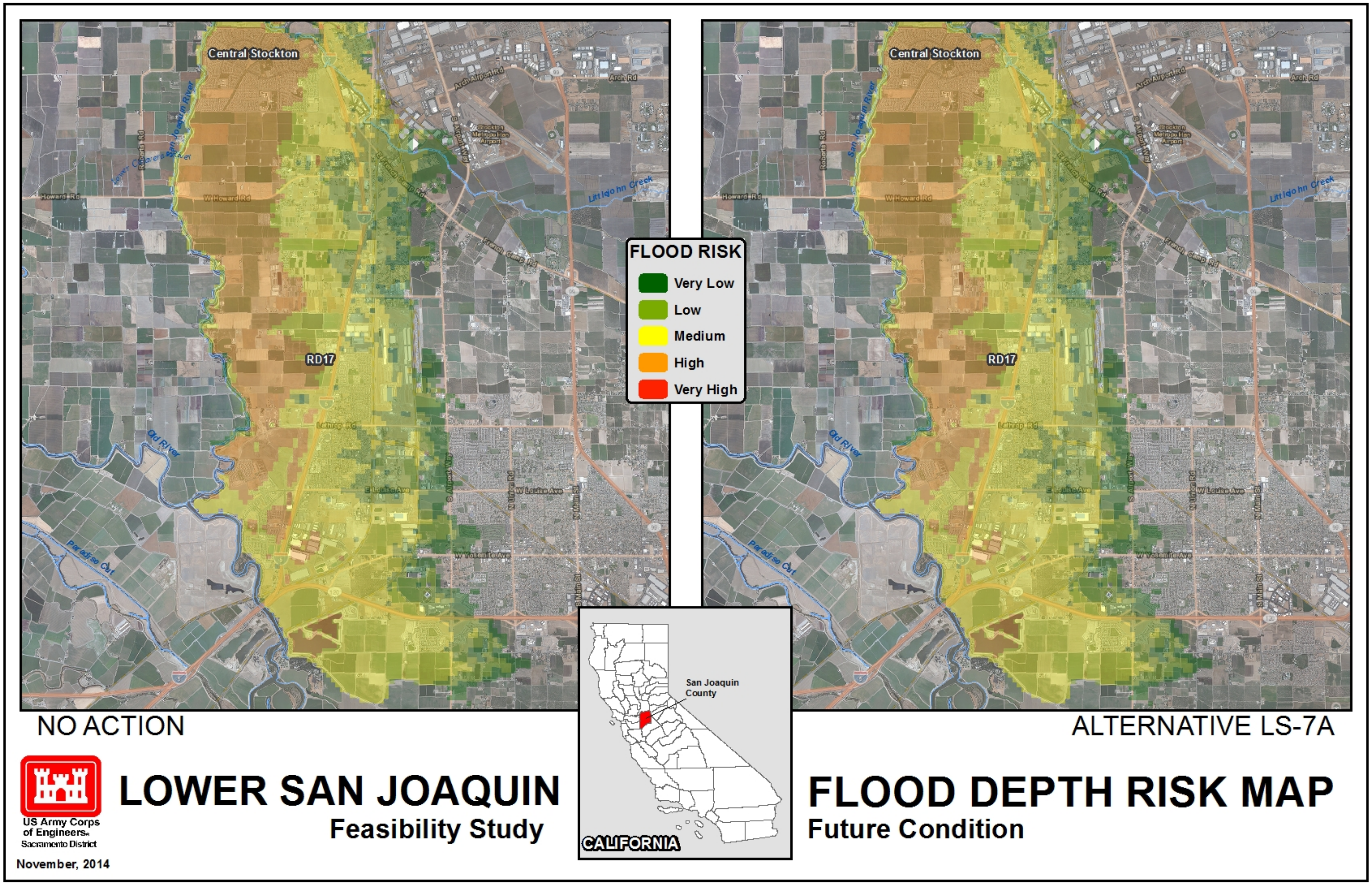


FIGURE 9: FLOOD RISK—RD17—FUTURE CONDITION



The second part of the life safety evaluation was to adjust the flood risk factors up or down based on population density in the affected area. The population density metric was selected because it represents the severity of consequences in the risk equation. In other words, the more people living in a flooded area, the higher the life safety risk, *ceteris paribus*. Conversely, the fewer people living in a flooded area, the lower the life safety risk, *ceteris paribus*.

According to the US Census Bureau, the average metropolitan statistical area (MSA) has a population density of roughly 4,400 people per square mile[1]. The population density of the LSJRFS study area is reasonably close to that estimate with an average of 4,126 people per square mile.

The risk matrix on page 11 is designed to describe flood risk in an area of average population density. For life safety risk estimation purposes, portions of the study area with a population density within one standard deviation below or two standard deviations above the mean population density were deemed average. Flood risk was assessed for these areas using the risk factors as shown in the matrix.

For areas more than two standard deviations above the mean, the risk factor was increased by one increment (medium becomes high, high becomes very high, etc.) For areas more than one standard deviation below the mean[2], the risk factor was reduced by one increment (medium becomes low, low becomes very low, etc.) Table 8 summarizes the risk adjustment factors and the total population affected by each factor adjustment. The maps in figures 10 through 13 provide graphic representations of the population density classifications shown in Table 8.

TABLE 8: RISK ADJUSTMENT BY DEVIATION FROM NATIONAL MEAN POPULATION DENSITY

POPULATION DENSITY DEVIATIONS FROM MEAN	RISK FACTOR ADJUSTMENT	POPULATION IMPACTED
More than 1 below	-1	8,978
1 below to 1 above	0	37,053
1 above to 2 above	0	62,547
2 above to 3 above	+1	45,618
More than 3 above	+1	73,258

[1] Data is from the report *Distance Profiles for U.S. Metropolitan Statistical Areas: 2000 and 2010* (US Census Bureau).

[2] Zero is 1.05 standard deviations below the mean. Therefore one standard deviation below the mean was deemed an appropriate threshold to define areas of low population density.

FIGURE 10: POPULATION DENSITY MAP—STUDY AREA

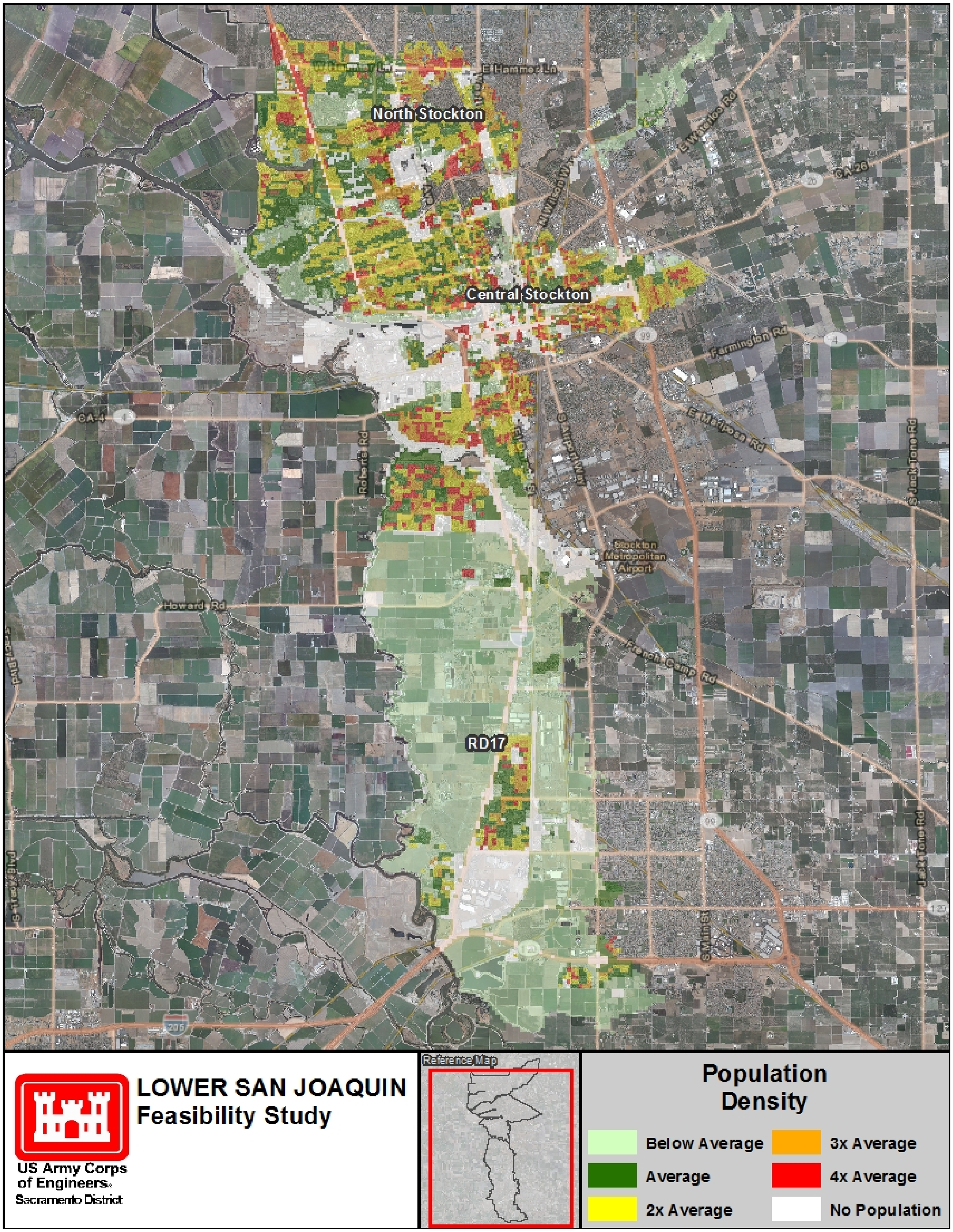


FIGURE 11: POPULATION DENSITY MAP—NORTH STOCKTON

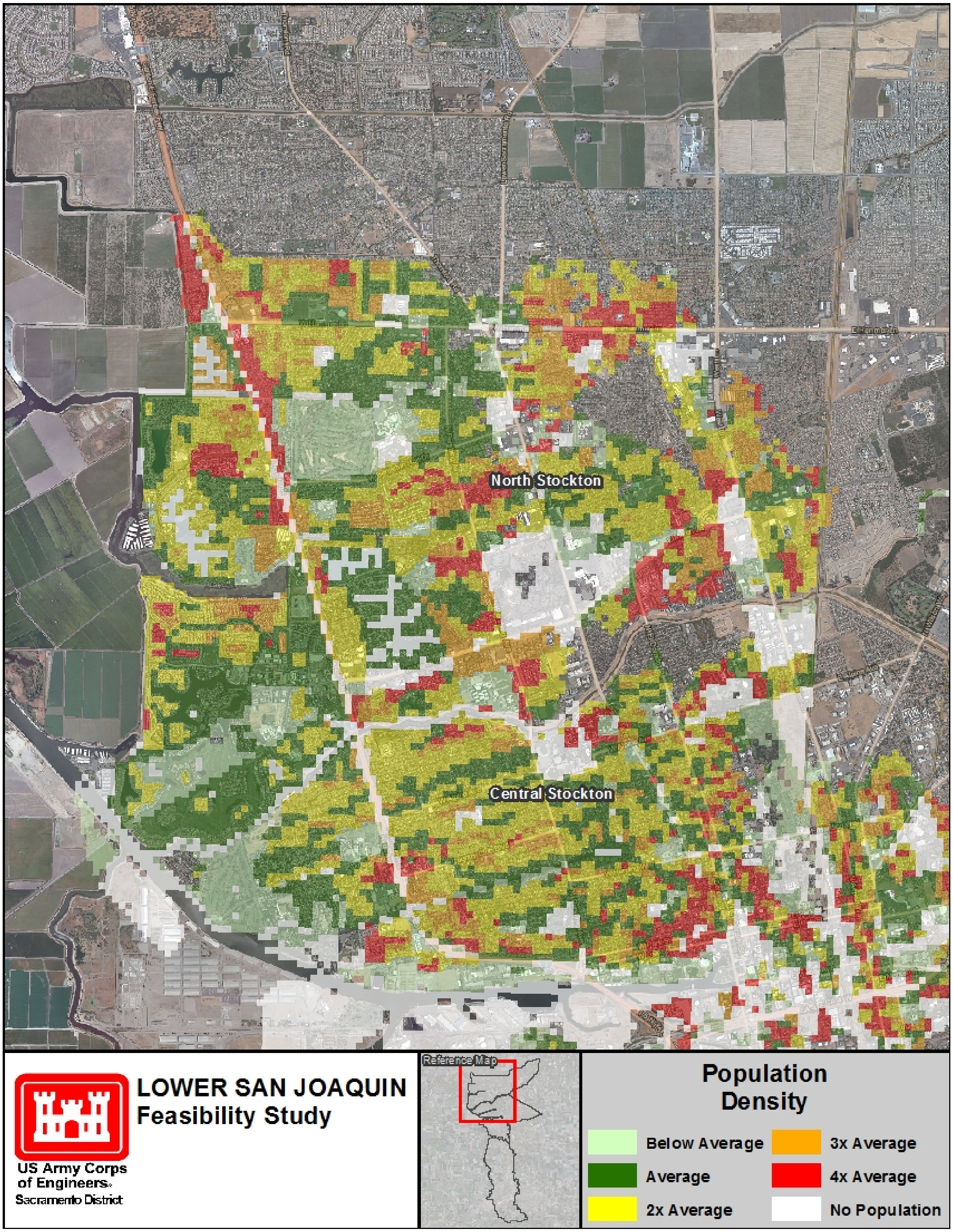


FIGURE 12: POPULATION DENSITY MAP—CENTRAL STOCKTON

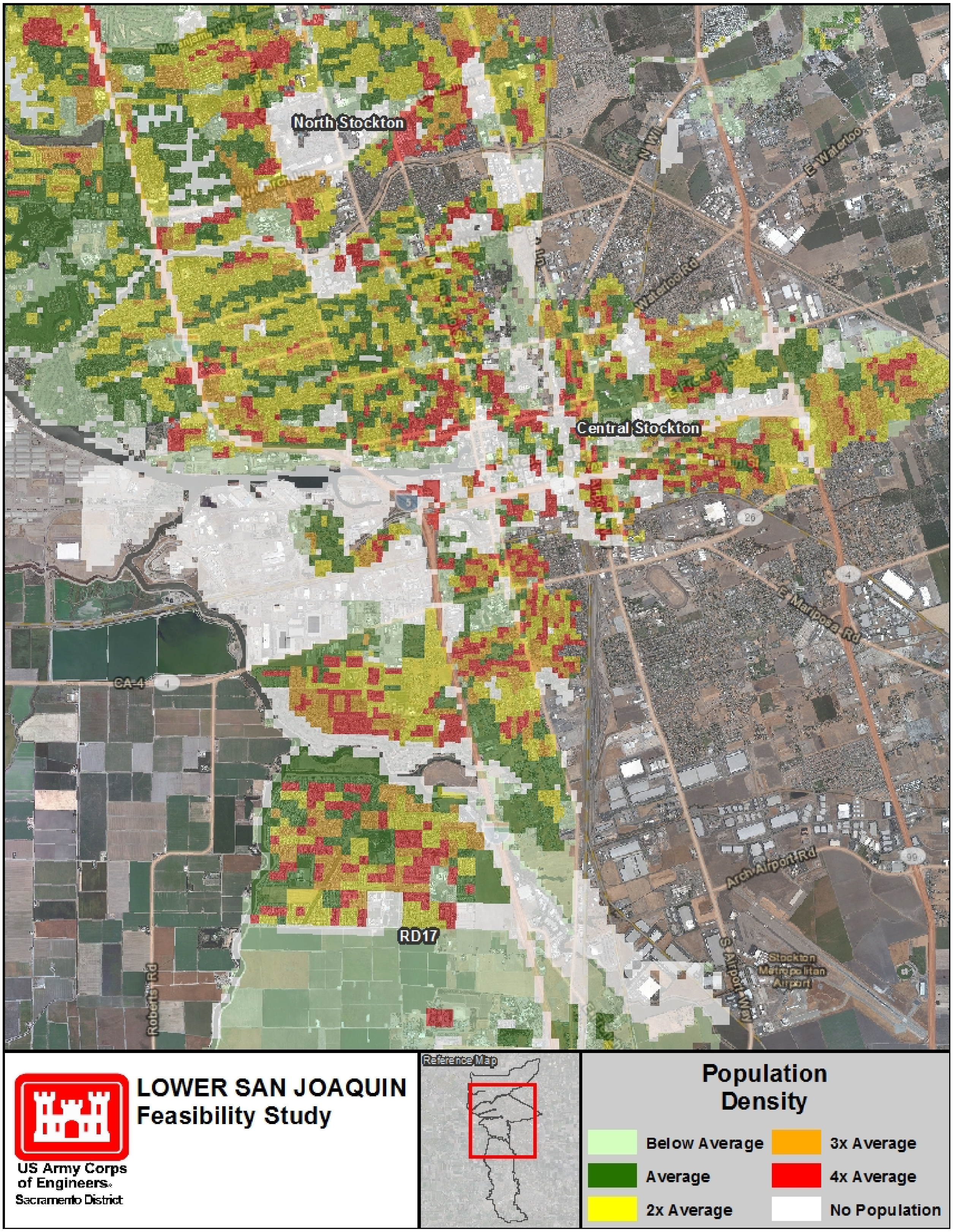
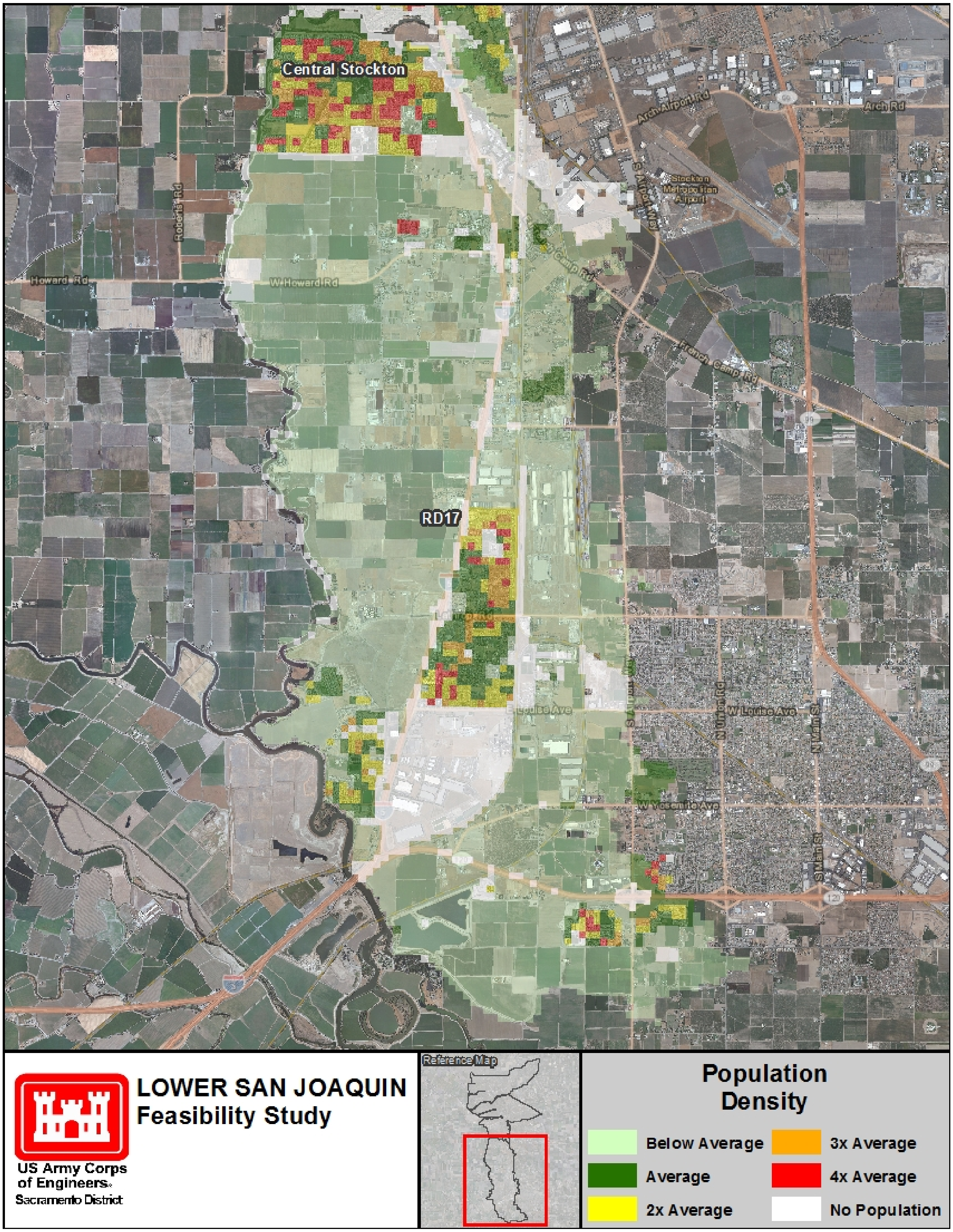


FIGURE 13: POPULATION DENSITY MAP—RD17



In this analysis, flood risk adjusted for population density will be referred as life safety risk. The tables and figures below compare life safety risk for the No Action alternative and Alternative LS-7a. Tables 9 and 10 list the number of people in each risk category for the existing and future condition. Tables 11 and 12 show the number of people affected by each combination of No Action and Alternative LS-7a life safety risk categories. The maps in figures 14 through 21 show existing and future life safety risk for both alternatives.

TABLE 9: POPULATION BY LIFE SAFETY RISK CATEGORY—EXISTING CONDITION

FLOOD RISK	ALTERNATIVE	
	NO ACTION	LS-7A
Very Low	29,249	29,489
Low	58,453	59,853
Medium	66,703	84,201
High	50,605	43,264
Very High	22,444	10,648

TABLE 10: POPULATION BY LIFE SAFETY RISK CATEGORY—FUTURE CONDITION

FLOOD RISK	ALTERNATIVE	
	NO ACTION	LS-7A
Very Low	27,658	29,462
Low	55,947	59,709
Medium	59,551	82,839
High	56,463	42,071
Very High	27,837	13,373

TABLE 11: PROJECT IMPACT ON LIFE SAFETY RISK—EXISTING CONDITION

RISK CATEGORY		POPULATION
No Action	LS-7a	
Very High	Very High	10,648
Very High	High	7,419
Very High	Medium	4,377
High	High	35,845
High	Medium	14,760
Medium	Medium	65,064
Medium	Low	1,639
Low	Low	58,213
Low	Very Low	240
Very Low	Very Low	29,249

TABLE 12: PROJECT IMPACT ON LIFE SAFETY RISK—FUTURE CONDITION

RISK CATEGORY		POPULATION
No Action	LS-7a	
Very High	Very High	13,373
Very High	High	9,687
Very High	Medium	4,776
High	High	32,383
High	Medium	24,079
Medium	Medium	53,984
Medium	Low	5,567
Low	Low	54,142
Low	Very Low	1,805
Very Low	Very Low	27,658

FIGURE 14: LIFE SAFETY RISK—STUDY AREA—EXISTING CONDITION

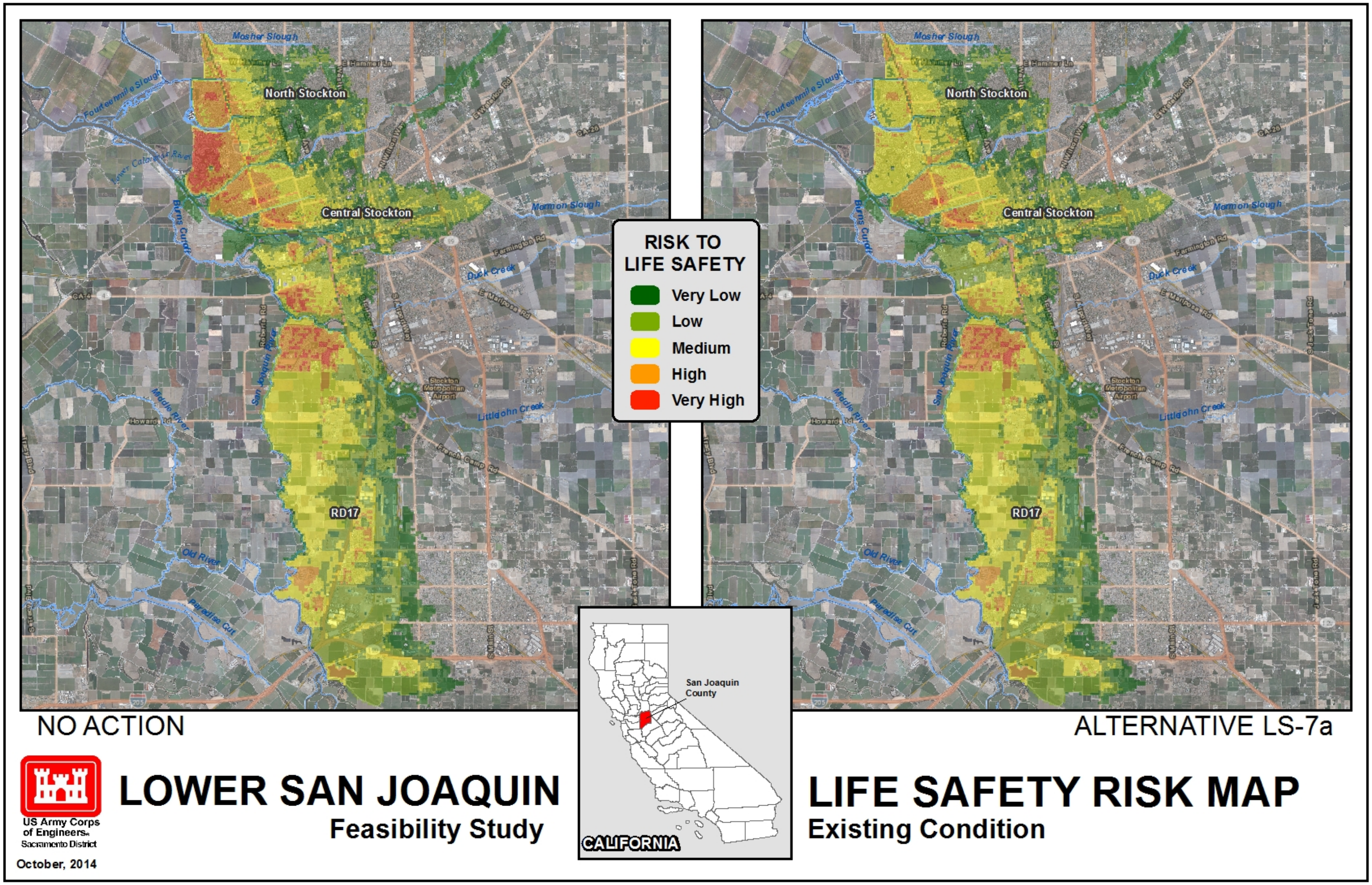


FIGURE 15: LIFE SAFETY RISK—STUDY AREA—FUTURE CONDITION

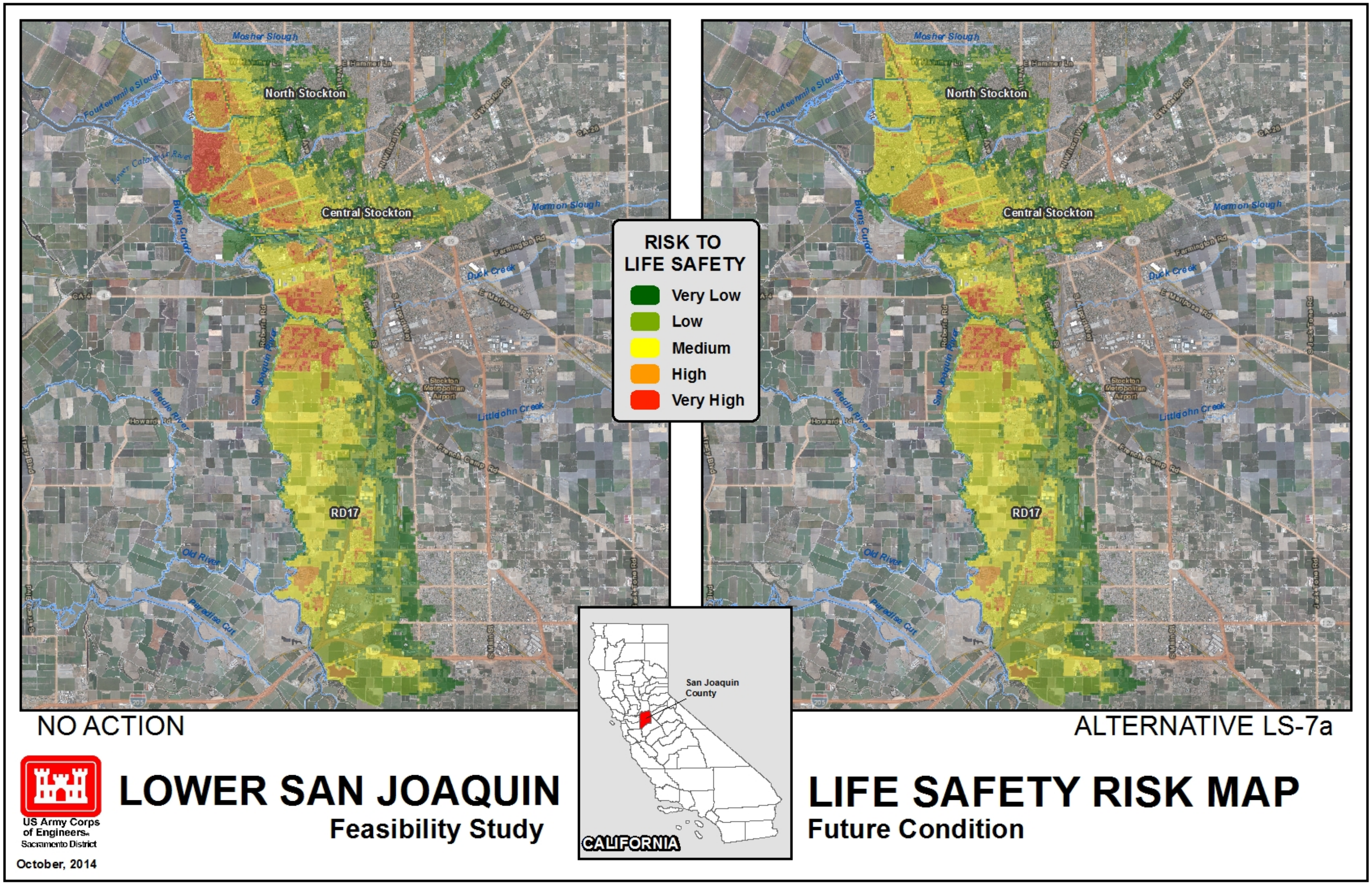


FIGURE 16: LIFE SAFETY RISK—NORTH STOCKTON—EXISTING CONDITION

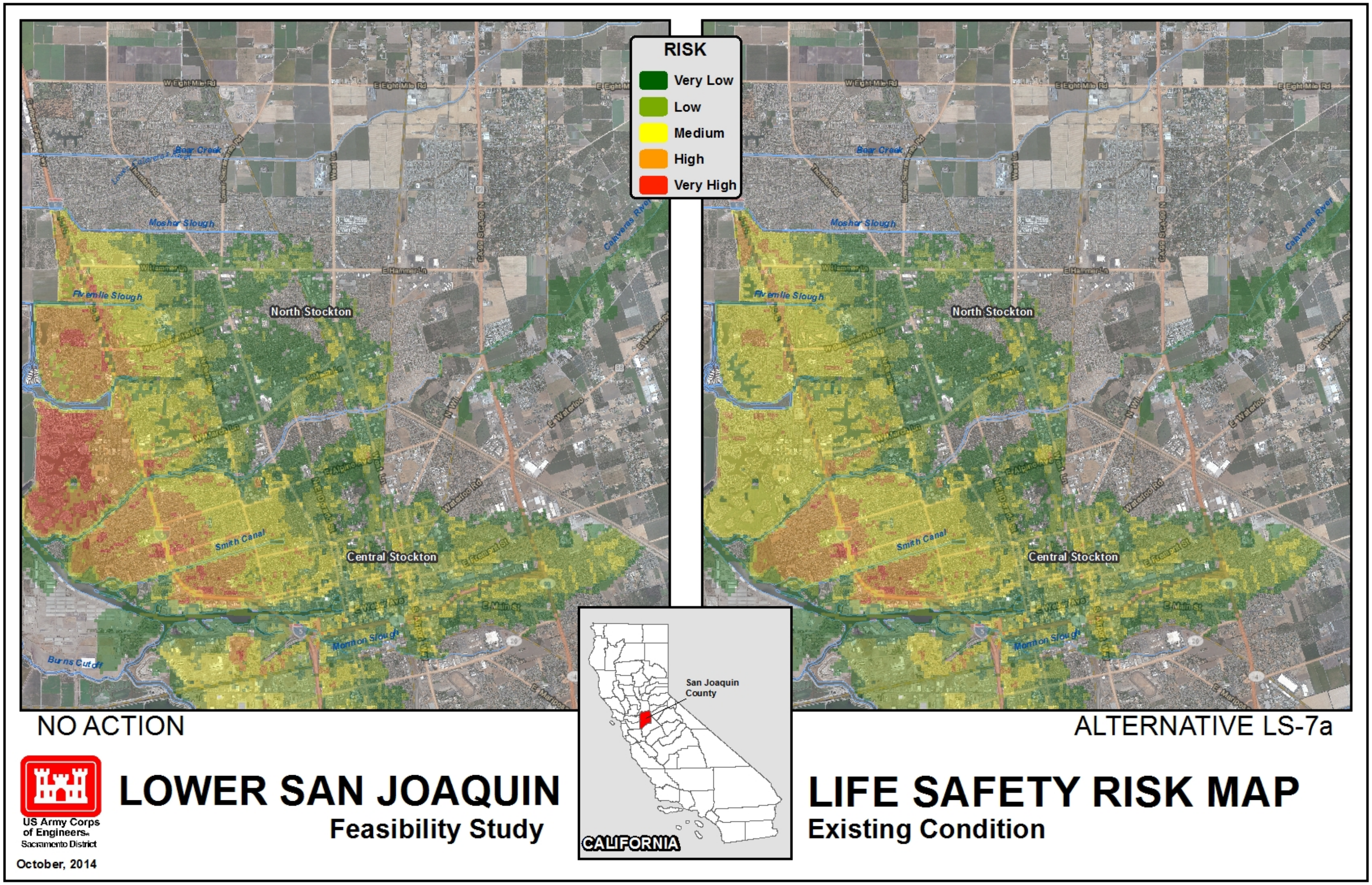


FIGURE 17: LIFE SAFETY RISK—NORTH STOCKTON—FUTURE CONDITION

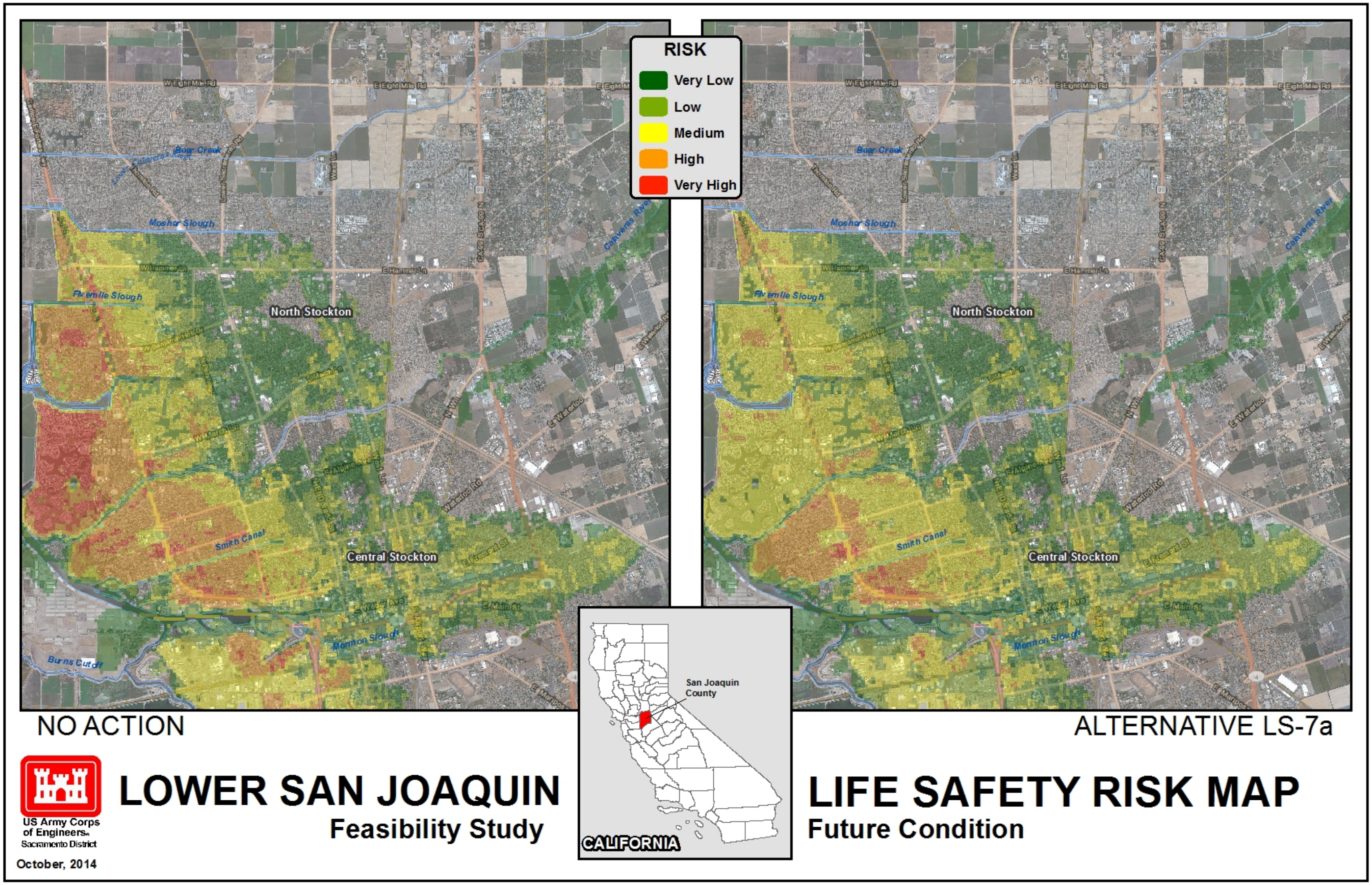


FIGURE 18: LIFE SAFETY RISK—CENTRAL STOCKTON—EXISTING CONDITION

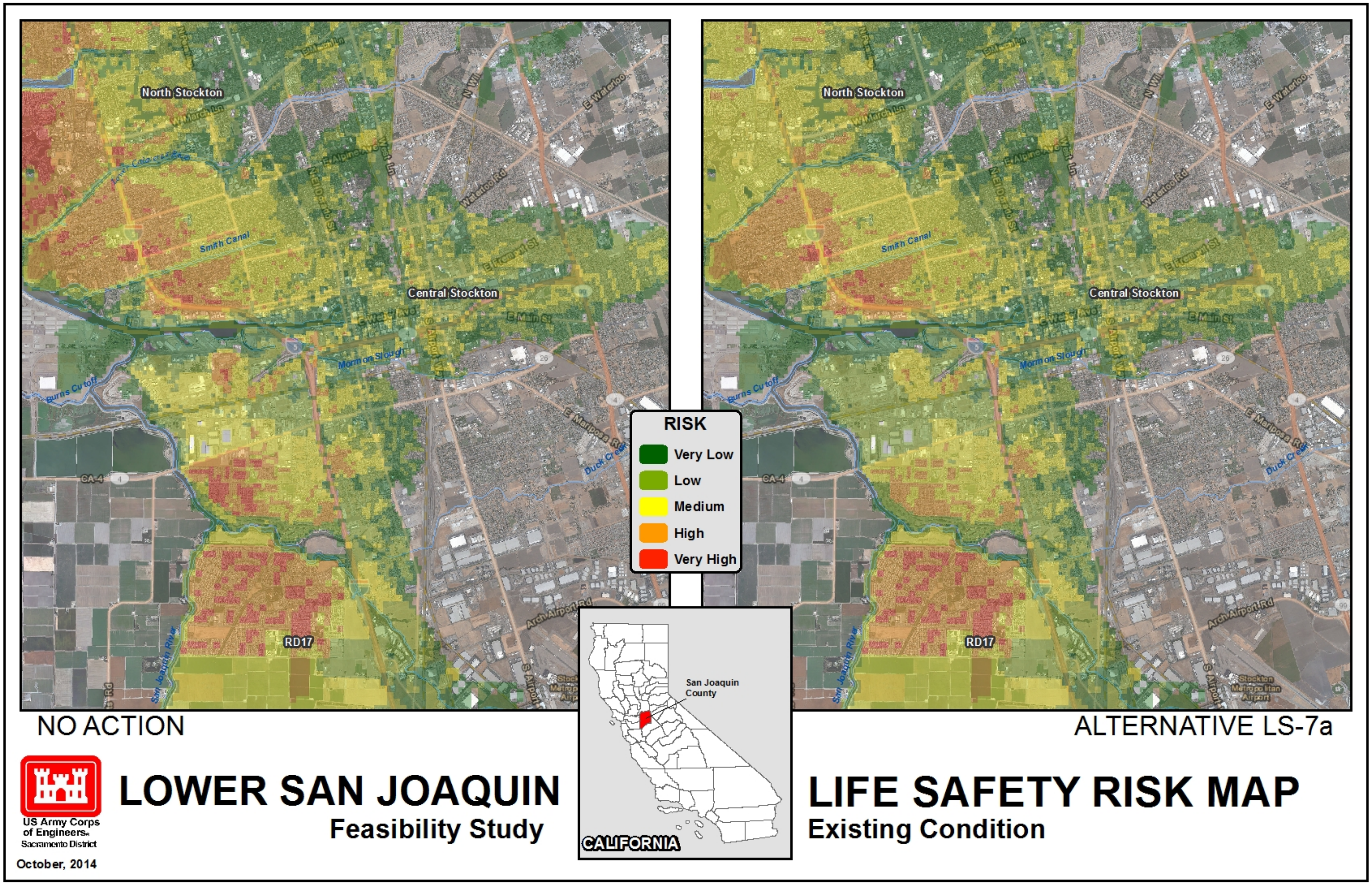


FIGURE 19: LIFE SAFETY RISK—CENTRAL STOCKTON—FUTURE CONDITION

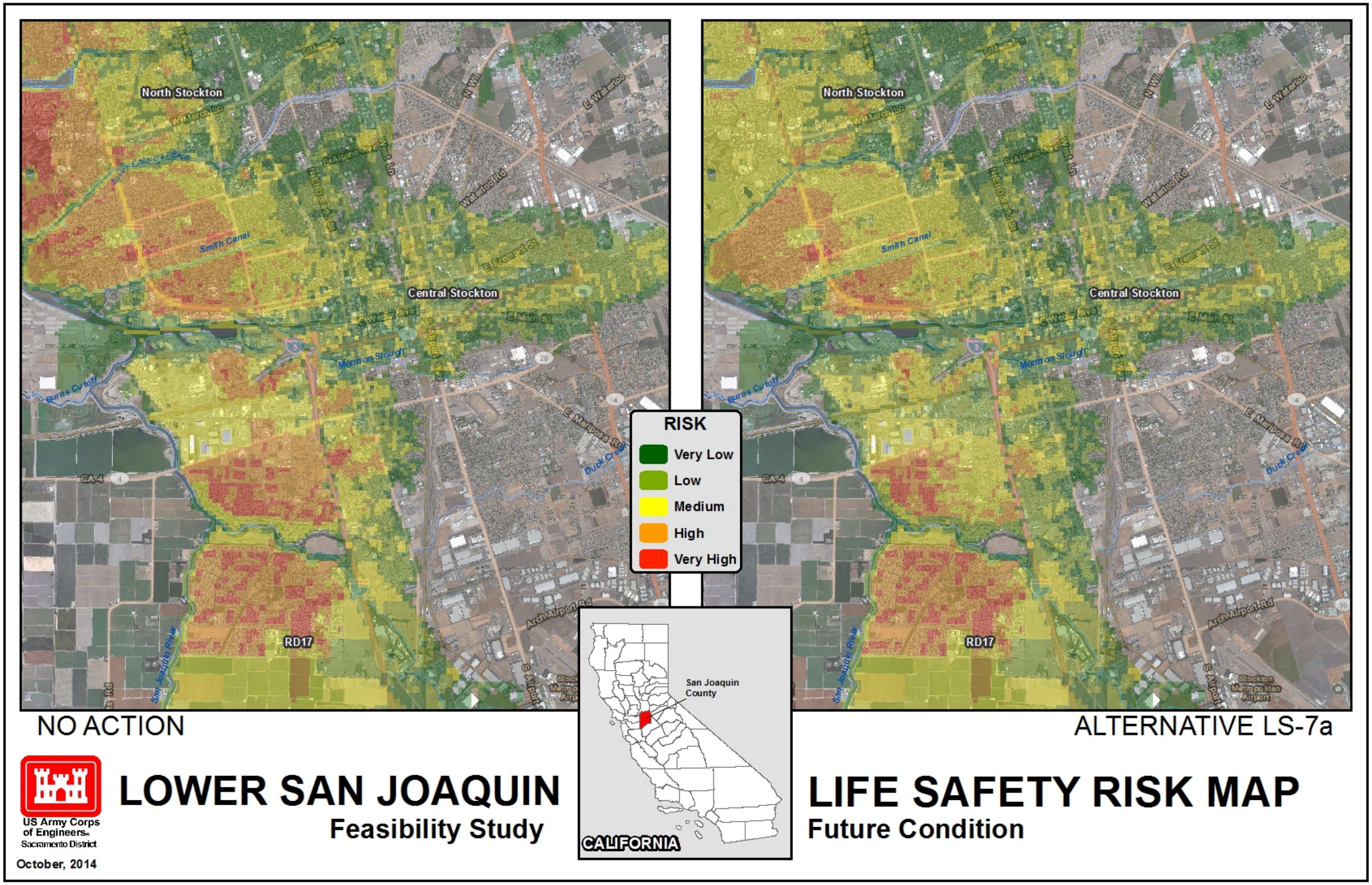


FIGURE 20: LIFE SAFETY RISK—RD17—EXISTING CONDITION

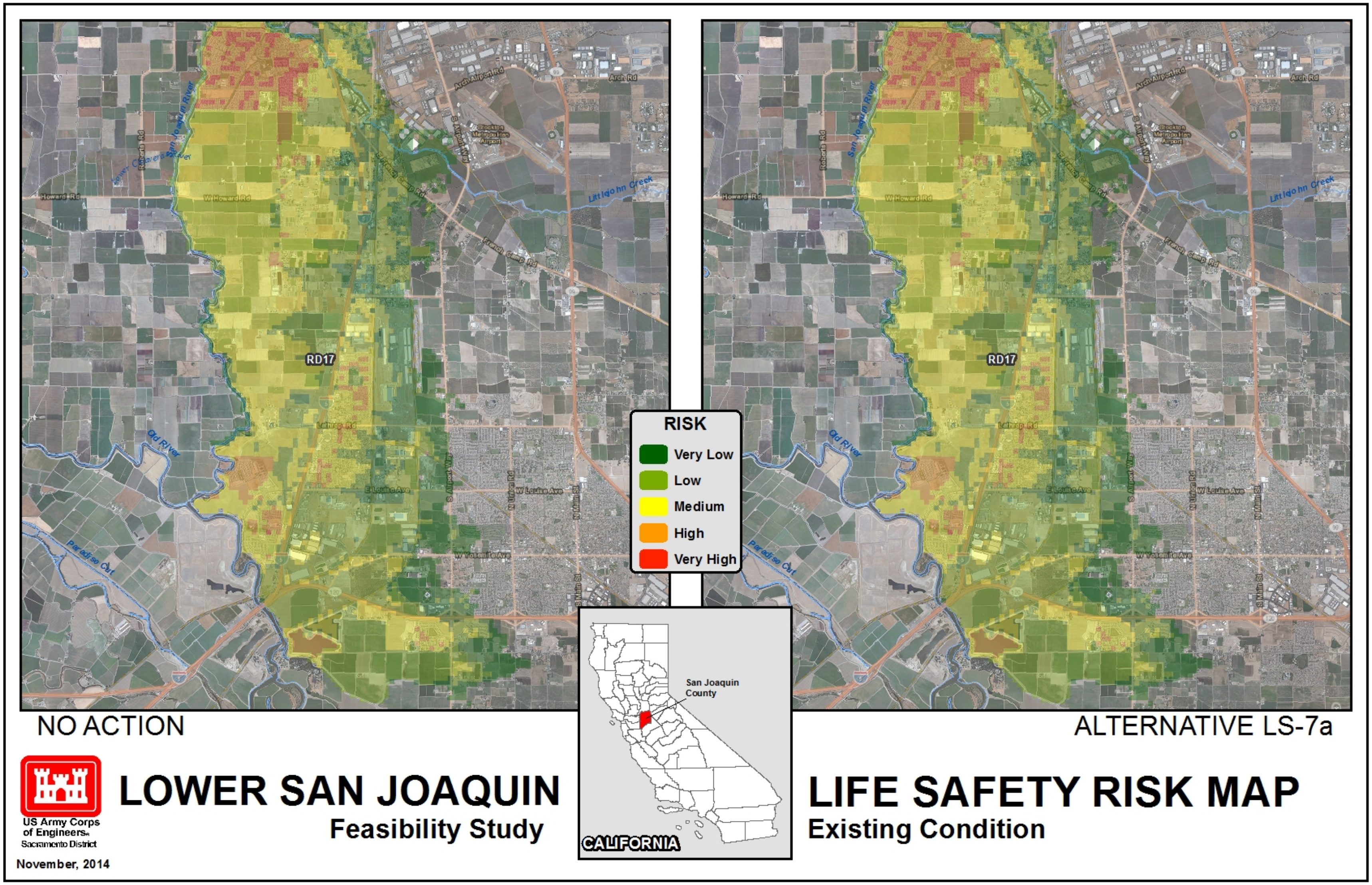
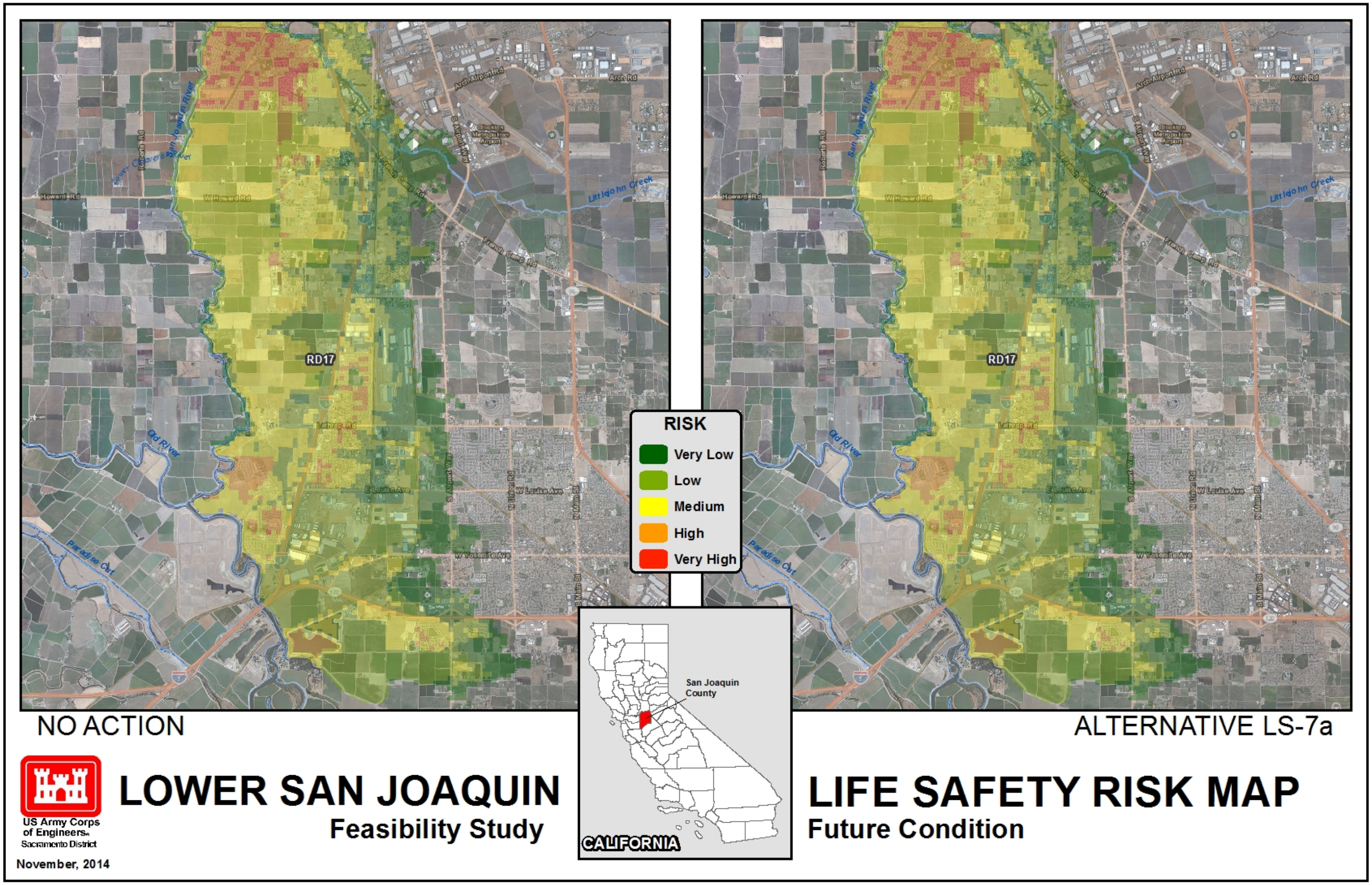


FIGURE 21: LIFE SAFETY RISK—RD17—FUTURE CONDITION



PART II — Regional Economic Development

Purpose and Methodology

The U.S. Army Corps of Engineers (USACE) Planning Guidance Notebook (ER 1105-2-100) states that while the National Economic Development (NED) and Environmental Quality (EQ) accounts are required, display of the Regional Economic Development (RED) effects are discretionary. The Corps' NED procedures manual affirms that RED benefits are real and legitimate; however, the concern (from a Federal perspective) is that they are often offset by RED costs in other regions. Nevertheless, for the local community these benefits are important and can help them in making their preferred planning decisions.

Although the RED account is often examined in less detail than NED, it remains useful. For example, Hurricane Katrina caused a significant economic hardship to not just the immediate Gulf Coast but for entire counties, watersheds, and the state of Louisiana. Besides the devastating damage to homes (which are often captured by the NED account), hundreds of thousands of people lost their jobs, property values fell, and tourism and tax revenues declined significantly and were transferred to other parts of the U.S. In this example, the RED account can provide a better depiction of the overall impact to the region.

The distinction between NED and RED is a matter of perspective, not economics. A non-federal partner may consider the impacts at the state, regional, and local levels to be a true measure of a project's impact or benefit, whereas from the Corps' perspective, this may not constitute a national benefit. Gains in RED to one region may be partially or wholly offset by losses elsewhere in the nation. For example, if a Federal project enables a firm to leave one state to relocate to a newly-protected floodplain of another state, the increase in regional income for the project area may come at the expense of the former area's loss. In this case, there is no net increase in the value of the nation's output of goods and services and should be excluded from NED computations.

The following sections describe the impacts of the tentatively selected plan (TSP) a regional perspective. The impacts were evaluated using the Corps' certified RECONS software.

Key RED Concepts

Econometric analysis allows for the evaluation of a full range of economic impacts related to specific economic activities by calculating effects of the activities in a specific geographic area. These effects are:

- Direct effects, which consist of economic activity contained exclusively within the designated sector. This includes all expenditures made by the companies or organizations in the industry and all employees who work directly for them.
- Indirect effects, which define the creation of additional economic activity that results from linked business, suppliers of goods and services, and provisions of operating inputs.
- Induce effects, which measure the consumption expenditures of direct and indirect sector employees.

Input-output (I/O) models are characterized by their ability to evaluate the effects of industries on each other. Unlike most typical measures of economic activity that examine only the total output of an industry or the final consumption demand provided by a given output, I/O models provide a much more comprehensive view of the interrelated economic impacts. I/O analysis is based on the notion that there is a fundamental relationship between the volume of output of an industry and the volume of the various inputs used to produce that output. Industries are often grouped into production, distribution, transportation, and consumption categories. Additionally, the I/O model can be used to quantify the multiplier effect, which refers to the idea that an increase in spending can lead to an even greater increase in income and consumption, as monies circulate (or multiply) throughout the economy.

FLOOD RISK MANAGEMENT RED CONSIDERATIONS

There are particular effects for each type of project improvement as they relate to the RED account. The estimation of RED flood-related effects can be very complex. At a minimum, the RED analysis should include a qualitative description of the types of businesses at risk from flooding, particularly those that could have a significant adverse impact (output, employment, etc.) upon the community or regional economies if their operations should be disrupted by flooding and how this would be affected by the recommended project. The potential RED effects to flood risk management projects are summarized in Table 13below.

TABLE 13: POTENTIAL RED EFFECTS TO FLOOD RISK MANAGEMENT

RED FACTOR	POTENTIAL RED EFFECTS
Construction	Additional construction related activity and resulting spillovers to suppliers
Revenues	Increased local business revenues as a consequence of reduced flooding, particularly from catastrophic floods
Tax Revenues	Increased income and sales taxes from the direct project and spillover industries
Employment	Short-term increase in construction employment; with catastrophic floods, significant losses in local employment (apart from the debris and repair businesses, which may show temporary gains)
Population Distribution	Disadvantage groups may benefit from the creation of a flood-free zone
Increased Wealth	Potential increase in wealth for floodplain residents as less is spent on damaged property, repairs, etc.; potential increase in property values.

RECONS SOFTWARE

A variety of software programs are available to measure the RED impacts of a project. The Corps of Engineers' Institute for Water Resources (IWR) along with the Louis Berger Group has developed a regional economic impact modeling tool called Regional Economic System (RECONS) that computes estimates of regional and national job creation, retention, and other economic measures. The expenditures made by the USACE for various services and products generate economic activity that can be measured in jobs, income, sales, and gross regional product. The software automates calculations and generates estimates of economic measures associated with USACE's annual civil works program spending. RECONS was built by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations by the Minnesota IMPLAN Group. These multipliers were then imported into a database. The software ties various spending profiles to the matching industry sectors by location to produce economic impact estimates. The RECONS program is used to document the performance of direct investment spending of the USACE, and allows users to evaluate project and program expenditures associated with annual expenditures.

REGIONAL PROFILE

The economic impacts presented below show the Lower San Joaquin River Feasibility study area and the state of California's interrelated economic impacts resulting from an injection of flood risk management construction funds. For this assessment, the study area and the state of California were both used as the geographic designation to assess the overall impacts to the regional economy from constructing the

TSP. This places a frame around the economic impacts where the activity is internalized; leakages, which are payments made to imports or value added sectors that do not in turn re-spend the dollars within the area, are not included in the total impacts.

Table 14 summarizes the complex nature of the regional economy of the Stockton, CA Metropolitan Statistical Area (MSA), which has a population of approximately 750,000. There are approximately 288,000 people employed in the MSA who provide an output to the nation of nearly $40 billion annually.

TABLE 14: REGIONAL PROFILE – STOCKTON, CA MSA (DOLLAR VALUES IN $MILLIONS, OCTOBER 2014 PRICE LEVEL)

INDUSTRY	OUTPUT	LABOR INCOME	GRP	EMPLOYMENT
Accommodations and Food Service	$968	$328	$495	17,075
Administrative and Waste Management Services	$929	$482	$606	16,388
Agriculture, Forestry, Fishing and Hunting	$2,197	$614	$1,046	19,679
Arts, Entertainment, and Recreation	$227	$64	$104	2,872
Construction	$2,773	$1,151	$1,260	18,849
Education	$823	$609	$681	14,617
Finance, Insurance, Real Estate, Rental and Leasing	$3,348	$783	$2,222	18,799
Government	$3,041	$2,348	$2,665	34,727
Health Care and Social Assistance	$2,735	$1,503	$1,762	30,375
Imputed Rents	$3,022	$447	$1,904	17,145
Information	$1,787	$196	$387	3,219
Management of Companies and Enterprises	$303	$132	$176	1,492
Manufacturing	$9,093	$1,335	$2,155	21,820
Mining	$74	$23	$45	230
Professional, Scientific, and Technical Services	$1,215	$505	$682	9,394
Retail Trade	$2,362	$1,015	$1,616	32,939
Transportation and Warehousing	$2,033	$897	$1,268	16,116
Utilities	$1,082	$176	$408	1,235
Wholesale Trade	$1,871	$703	$1,208	11,425
Total	**$39,883**	**$13,311**	**$20,690**	**288,396**

INPUT COSTS

The RED analysis requires the adjustment of costs for two items: (1) interest during construction (IDC) and (2) purchases of land. Interest during construction is used in the NED analysis to estimate the opportunity cost of using money for one economic endeavor (*e.g*., building a FRM project) instead of another (*e.g*., building a bullet train); IDC is not actually expended within the region and therefore is not included in the RED analysis. Similarly, the purchase of land, not including administrative costs, is considered a transfer payment from one party to another and therefore is also not included in the RED analysis. The total remaining costs of the TSP is $517,801,000.

Table 15 shows the regional expenditures expected over the 11 year construction period. The expected annual expenditure is roughly $47 million. Local capture rates are provided by RECONS and show where the output from expenditures is realized.

TABLE 15: TSP INPUTS ASSUMPTIONS—STOCKTON, CA MSA

CATEGORY	SPENDING	SPENDING AMOUNT	LOCAL PERCENTAGE CAPTURE		
			LOCAL	STATE	NATIONAL
Aggregate Materials	8.3%	$43,076,775	74%	77%	97%
Other Materials	1.1%	$5,916,871	100%	100%	100%
Equipment	29.2%	$150,993,640	82%	99%	100%
Construction Labor	46.1%	$238,602,790	100%	100%	100%
Explosives Materials	0.1%	$439,572	8%	47%	86%
Cement Materials	0.3%	$1,794,919	7%	73%	92%
Metals and Steel Materials	1.2%	$6,263,901	18%	56%	90%
Machinery Materials	0.5%	$2,710,694	13%	46%	79%
Electrical Materials	0.6%	$3,150,266	19%	44%	80%
Lumber Materials	0.1%	$439,572	24%	56%	90%
Cultural Resources Protection Activities	2.8%	$14,592,000	40%	99%	99%
Fish Hatcheries, Wildlife Facilities, and Sanctuaries	9.6%	$49,820,000	100%	100%	100%
Total	**100%**	**$517,801,000**	**88.5%**	**96.4%**	**99.3%**

RECONS OUTPUT

The expenditures made by the Corps of Engineers for various services and products are expected to generate additional economic activity, which can be measured in jobs, income, sales, and GRP. These impacts are summarized in Tables 16 through 18 (economic activity on regional, state, and national basis).

TABLE 16: SUMMARY OF ECONOMIC IMPACTS

		REGIONAL	STATE	NATIONAL
Direct Impact	Output	$457,920,499	$499,184,217	$513,950,423
	Jobs	$6,152	$6,318	$6,390
	Labor Income	$318,105,873	$332,625,180	$339,076,586
	GRP	$363,579,956	$386,604,753	$394,679,283
Total Impact	Output	$802,934,646	$1,016,660,600	$1,371,534,378
	Jobs	$8,624	$9,761	$11,675
	Labor Income	$433,463,030	$510,646,814	$624,475,268
	GRP	$571,957,806	$694,794,105	$888,588,856

TABLE 17: REGIONAL ECONOMIC IMPACTS

Industry Sector	Sales	Jobs	Labor Income	GRP
Direct Effects				
Wholesale trade businesses	$1,483,655	8	$560,373	$1,118,727
Transport by rail	$1,151,469	3	$353,202	$610,689
Transport by water	$327,013	1	$83,163	$158,500
Transport by truck	$14,937,266	107	$7,252,626	$8,543,227
Construction of other new nonresidential structures	$5,916,871	33	$2,487,517	$3,096,192
Commercial and industrial machinery and equipment rental and leasing	$123,305,157	375	$34,237,323	$69,882,421
Labor	$238,602,790	5,198	$238,602,790	$238,602,790
All other chemical product and preparation manufacturing	$4,559	0	$373	$726
Cement manufacturing	$0	0	$0	$0
Steel product manufacturing from purchased steel	$405,949	1	$84,742	$100,655
Other industrial machinery manufacturing	$51,246	0	$16,483	$19,256
Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$15,674,892	72	$9,334,131	$10,444,986
Switchgear and switchboard apparatus manufacturing	$233,406	1	$52,055	$107,983
Retail Stores - Furniture and home furnishings	$22,508	0	$8,307	$14,383
Retail Stores - Electronics and appliances	$69,323	1	$22,252	$37,112
Retail Stores - Building material and garden supply	$3,772	0	$1,767	$2,593
Transport by air	$1,473	0	$25	$450
Engineered wood member and truss manufacturing	$51,089	0	$16,814	$21,259
Scientific research and development services	$5,882,202	42	$2,446,999	$2,450,038
Maintenance and repair construction of nonresidential structures	$49,795,863	311	$22,544,933	$28,367,970
Total Direct Effects	$429,375,535	5,776	$298,883,003	$342,335,820
Secondary Effects	$322,890,493	2,312	$107,993,154	$194,987,838
Total Effects	**$752,266,028**	**8,089**	**$406,876,156**	**$537,323,658**

TABLE 18: STATE ECONOMIC IMPACTS

Industry Sector	Sales	Jobs	Labor Income	GRP
Direct Effects				
Wholesale trade businesses	$2,582,269	15	$1,043,716	$1,974,155
Transport by rail	$1,151,469	3	$353,202	$610,689
Transport by w ater	$340,031	1	$86,475	$164,809
Transport by truck	$14,937,266	107	$7,252,626	$8,543,227
Construction of other new nonresidential structures	$5,916,871	33	$2,487,517	$3,096,192
Commercial and industrial machinery and equipment rental and leasing	$149,354,072	456	$41,470,151	$84,645,479
Labor	$238,602,790	5,198	$238,602,790	$238,602,790
All other chemical product and preparation manufacturing	$161,566	0	$25,076	$36,601
Cement manufacturing	$1,121,507	2	$251,323	$510,405
Steel product manufacturing from purchased steel	$2,455,936	5	$512,677	$608,952
Other industrial machinery manufacturing	$742,013	3	$238,661	$278,817
Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$16,536,071	78	$9,846,949	$11,018,834
Sw itchgear and sw itchboard apparatus manufacturing	$767,908	2	$172,330	$356,004
Retail Stores - Furniture and home furnishings	$32,899	0	$12,598	$21,283
Retail Stores - Electronics and appliances	$108,039	1	$41,858	$62,750
Retail Stores - Building material and garden supply	$3,772	0	$1,767	$2,593
Transport by air	$11,337	0	$2,803	$5,310
Engineered w ood member and truss manufacturing	$162,827	1	$53,587	$67,755
Scientific research and development services	$14,399,714	102	$7,624,143	$7,630,138
Maintenance and repair construction of nonresidential structures	$49,795,863	311	$22,544,933	$28,367,970
Total Direct Effects	$405,833,177	5,551	$283,929,227	$328,982,424
Secondary Effects	$410,515,217	2,787	$141,300,173	$244,905,267
Total Effects	**$816,348,394**	**8,337**	**$425,229,400**	**$573,887,691**

TABLE 19: NATIONAL ECONOMIC IMPACTS

Industry Sector	Sales	Jobs	Labor Income	GRP
Direct Effects				
Wholesale trade businesses	$2,617,282	15	$1,059,120	$2,001,417
Transport by rail	$1,359,488	4	$419,610	$723,076
Transport by w ater	$492,478	1	$125,244	$238,699
Transport by truck	$15,727,307	113	$7,636,223	$8,995,083
Construction of other new nonresidential structures	$5,916,871	33	$2,487,517	$3,096,192
Commercial and industrial machinery and equipment rental and leasing	$150,773,053	462	$41,864,150	$85,449,678
Labor	$238,602,790	5,198	$238,602,790	$238,602,790
All other chemical product and preparation manufacturing	$330,782	1	$55,227	$80,316
Cement manufacturing	$1,464,137	3	$328,104	$666,338
Steel product manufacturing from purchased steel	$4,537,693	9	$947,244	$1,125,126
Other industrial machinery manufacturing	$1,633,695	7	$525,461	$613,873
Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$23,911,121	124	$14,238,665	$15,933,209
Sw itchgear and sw itchboard apparatus manufacturing	$1,899,499	5	$446,617	$921,609
Retail Stores - Furniture and home furnishings	$33,882	0	$13,004	$21,936
Retail Stores - Electronics and appliances	$108,313	1	$41,997	$62,931
Retail Stores - Building material and garden supply	$3,800	0	$1,780	$2,612
Transport by air	$15,114	0	$3,876	$7,187
Engineered w ood member and truss manufacturing	$310,936	2	$102,330	$129,386
Scientific research and development services	$14,406,385	102	$7,628,198	$7,634,196
Maintenance and repair construction of nonresidential structures	$49,805,796	0	$0	$0
Total Direct Effects	$513,950,423	6,079	$316,527,156	$366,305,654
Secondary Effects	$857,583,955	4,755	$256,080,670	$443,786,015
Total Effects	**$1,371,534,378**	**10,834**	**$572,607,826**	**$810,091,669**